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WITH

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SURGERY, GYNECOLOGY AND OBSTETRICS

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BONE AND JOINT DISEASE IN RELATION TO TYPHOID FEVER[1]

BY JOHN B. MURPHY, M.D., F.R.C.S. (HON. ENG.), CHICAGO

IN order that we may form a proper perspective and have a due sense of proportion of the relations of typhoid infection to osseous and arthritic diseases, it is important to place before us some statistics on the primary infection, the typhoid, and also of the secondary metastatic manifestations of the disease in relation to age, sex, frequency of secondary bone and joint disease, etc. We can then more accurately weigh the elements of the various manifestations in pathologic anatomy, clinical course, symptoms, diagnosis, as well as the treatment and prophylaxis of the complications. The treatment of typhoid bone and joint infections has been far from satisfactory in its results. To try to improve this is the purpose of this paper.

AGE INCIDENCE OF TYPHOID FEVER IN 7,269 CASES

Years	Cases	Per Cent
1 to 15	1,440	18.4
15 to 20	1,782	24.5
20 to 30	2,880	39.6
30 to 40	826	11.3
40 to 50	280	
50 to 60	43	
More than 60	18	

SEX INCIDENCE OF TYPHOID FEVER IN 9,124 CASES

	Cases
Males	5052
Females	4072

The male is more exposed in drinking and eating in out-of-the-way places than the female, and therefore more exposed to infection, which may account for the excess of the disease in his sex.

FREQUENCY OF POST-TYPHOID PERIOSTITIS AND OSTEITIS

In 18,840 cases of typhoid reported by fifteen authors, there were 164 cases of periostitis and osteitis; 0.82 per cent of all cases have metastatic bone disease.

In 700 cases of osteomyelitis, only 3 were due to typhoid, as estimated by Funke, or 0.43 per cent of all osteomyelitic cases. This is a very uncertain percentage, as in so many cases of osteomyelitis the history was not carefully analyzed and the bacteriology not actually determined. The bone lesions that are most frequent after those of the larynx (chondritis, etc.) are given in the later statistics (Keen).

They are undoubtedly more frequent than recorded, as in a large percentage of the bone-abscess cases the bacteriology is never properly worked out, and in a great number the infection does not suppurate and open or be opened, but has frequent subcutaneous recurrences of pain, swelling, fever, etc.

AGE AND SEX OF PATIENTS WITH TYPHOID BONE LESIONS (NO JOINTS)

Sex	Spine	Other Bones	Total	Per Cent
Males	92	238	330	73
Females	16	106	122	27
	108	344	452	

The spine represents less than 25 per cent of the total number. It is difficult to say what percentage of spine disease is due to osteitis, to periostitis, or to perichondritis.

[1] Read in part before the American Surgical Association, Rochester, Minnesota, June, 1915.

Age	Spine	Other Bones	Tota
Less than 20	24	76	100
20 to 30	21	100	121
30 to 40	14	51	65
More than 40	12	54	66
"Adult"	..	17	17
	71	298	369

The age extremes are ten years (spine) and sixty-nine years (rib).

Metastasis to the ribs and costal cartilages takes place later in life, as observed by Keen and others. I never saw one under the age of twenty-six.

Less than 20	1
20 to 30	9
30 to 40	15
More than 40	28
"Adult"	4
	57

These 57 cases are included in the 369 above.

The age incidence of typhoid periostitis and pyogenic non-typhoid osteomyelitis is as follows:

POST-TYPHOID PERIOSTITIS, 68 CASES

1 to 10 years	6	61.7 per cent
10 to 20 years	22	
20 to 25 years	14	
More than 25 years	26	33.8 per cent

PRIMARY OSTEOMYELITIS, 411 CASES

1 to 10 years	108	26.15 per cent
10 to 20 years	246	59.56 per cent
20 to 25 years	25	6.0 per cent
More than 25 years	32	8.29 per cent (Wurtz)

It can be seen from these comparative tables that both the typhoid periostitis and the septic osteomyelitic disease have about the same percentage frequency, ten to twenty-five years, and in osteomyelitis septica there is great preponderance over typhoid periostitis before the age of ten and a like preponderance of typhoid periostitis over twenty-five years, compared with osteomyelitis.

The osteomyelitic disease (non-typhoid) is pre-eminently a disease of the growing stage of bone development, as well as the period of the most frequent throat, nasal, and bronchial infections, which metastasize in the growing or maturing bone. There is a definite age and season relation between the acute upper air-passage infections and bone disease, as well as between these infections and duodenal and gastric ulcers. They are both probably due to metastases from the same sites of primary infection in the upper air passages.

LOCATION OF 533 TYPHOID BONE LESIONS

Head:		
Skull (special bone not given)	3	
Mastoid	3	
Frontal	2	
Maxilla	8	
Parietal	2	
Mandible	4	22
Spine		110
Thorax:		
Sternum	7	
Ribs	135	142
Upper extremity:		
Clavicle	7	
Scapula	3	
Humerus	15	
Forearm (bone not given)	2	
Radius	5	
Ulna	18	
Hand	7	57
Lower extremity:		
Pelvis	9	
Femur	33	
Tibia	127	
Fibula	4	
Foot	10	183
Multiple		19
Total		533

Note the frequency in the long, most compact bones, as the humerus, ulna, femur, and tibia. These are the bones most exposed to mild traumas.

The ribs, tibia, and spine represent 70 per cent of all the cases. The spine is greatly exposed to trauma and occupational continued pressure, and is much more frequently the site of metastatic disease of this origin than was formerly supposed.

When the long bones are diseased, the *shaft* rather than the *metaphysis* is the site involved, which is the reverse of the mode of attack in pyogenic metastatic osteomyelitis.

Varieties of typhoid osteitis. It is very difficult to classify the varieties of bone disease of typhoid origin, as the variations are mostly of a degree of destruction or of a virulence compared with the patient's resistance.

According to Hutinel there are three forms of diverse gross phenomena:

1. Circumscribed, without serious febrile phenomena, of minor degree, short duration, and with complete recovery. This form attracts the least attention, yet it seems most frequent. The patient seems to be able automatically to overpower the infection.

2. Suppurative, with marked general and local phenomena—fever, local swelling at focus, the skin is raised and becomes red, while pus is evacuated either spontaneously or by incision. This form is less frequent than the first. Here one rarely sees the "collar-button" absorption.

3. With slow onset, local swelling, and deformity of bone, thickening of the periosteum, subperiosteal osseous hyperplasia, and frequent collar-button excavations.

Klemm recognizes but two varieties, the first with subvarieties, and these merge into each other.

1. Specific typhoid osteitis.
   - *a*. Cortical osteitis, with tendency to spontaneous resorption.
   - *b*. Cortical osteitis, with tendency to caseation, or desiccation of the products of infection.
   - *c*. Cortical osteitis, with tendency to liquefaction.
   - *d*. Central osteitis, ending in osteomyelitis.

It will be noted how frequently the cortex periosteum compared with the medulla, the reverse occurring in metastatic osteomyelitis.

2. Suppuration in the bone marrow — suppurative myelitis. The slowness of onset and the chronicity of the process are quite characteristic of the disease. The hyperplasia of the bone and the subperiosteal hypertrophy of the bone contrast acutely with the radiographic appearance of tuberculous foci in bone.

NATURE OF BONE LESIONS

Periostitis	128
Necrosis	110
"Typhoid spine"	110
Osteitis (bone abscess)	29
Osteomyelitis	27
Caries	21
Chondritis	11
Perichondritis	11
Exostosis	4
Granuloma	3
	454

While 28 per cent of the cases are charged up as periostitis, the periosteum is always affected in the osteal disease, and I am sure from my observations of the X-ray showings that the bone is many times deeply involved when the diagnosis of periostitis is made.

"Syphilis in which, *par excellence*, periostitis is usually encountered, has been termed by Mr. Hutchinson 'an exanthem long drawn out,' and it is interesting to note that in the most protracted of the specific fevers of this country (Great Britain)—enteric fever—periostitis is occasionally met with." (Mackenzie.)

Syphilis is likely to be mistaken for typhoid osteitis. One of my cases after typhoid had large exostoses on the tibia, but they were present on the skull also. The Wassermann test was positive. Specific treatment led to rapid cure. (Hutinel.)

Typhus fever is also attended by bone lesions. In one of my cases there was extensive necrosis of the fibula. (Murchison.)

The Widal, Wassermann, and the spirochætic tests now aid in making the differential diagnoses. The X-ray pictures of typhoid and spirochætic periosteal and osteal disease show marked contrasts which are easily recognized by one versed in X-ray readings.

BACTERIOLOGIC EXAMINATIONS — BONES ONLY

Paratyphoid	3
Bacillus typhosus	71
Bacillus typhosus and bacillus coli	1
Bacillus typhosus and pus microbes	2
Pus microbes only	15
Cultures sterile	7
Total number of examinations	99

The detection of the bacillus typhosus is easily accomplished if one looks for it. In one case there was present a pure culture of bacillus typhosus, notwithstanding there was an open sinus for six years, showing the tenacity of the bacillus to life even when drainage exists (Sultan). In another case pure cultures of bacillus typhosus were present at first; later only the streptococcus aureus was found (Parsons).

The striking feature in the above table is the *infrequency of mixed infection*, which should play a great rôle in the specific and constitutional treatment of the disease. One

is also struck by the example of persistence of the bacillus typhosus with the sinus open and drainage perfect, showing that something more than drainage is needed in the treatment of these lesions.

CASES OF PARATYPHOID INFECTION

Spine	2 cases
Ribs	1 case
Femur	1 case
Tibia	1 case

PERSISTENCE OF BACILLI IN BONES

23.0 years (Fogh)	femur
15.0 years (Picque)	no details
13.0 years (Tubby and Hicks)	ulna
11.0 years (Gore)	frontal
7.0 years (Bush)	tibia
7.0 years (Buschke)	ribs
6.5 years (Kirk)	femur
6.0 years (Bruni)	tibia
6.0 years (Sultan)	clavicle
4.0 years (Chantemasse)	multiple foci
3.5 years (Lilienthal)	tibia

Jansen and Koch found the paratyphoid bacillus in the femur as late as twenty years after the fever.

The long persistence of living bacillus typhosus in drained bone cavities is in accord with its long life in the gall-bladder, which is also a drained cavity, as shown by the following table:

PERSISTENCE OF BACILLI IN GALL-BLADDER

14 years (von Dungern).
18 years (Hunner).
18 years (Lumsden and Woodward).
20 years (Forster).
29 years (Dian).
30 years (Phillipowicz).
39 years (von Eiselsberg).
50 years (Jundell).
52 years (Gregg).

A man, aged forty-nine years, was admitted to von Eiselsberg's clinic for gall-stones. He had had typhoid at the age of eleven. Typhoid bacilli were cultivated from the bile after his admission to the hospital.

The type of primary typhoid was as follows:

	Spine	Other Bones	Total
Mild or moderate	38	10	48
Severe	26	15	41

The time of onset of bone manifestations was as follows:

	Spine	Other Bones	Total
During attack of typhoid	6	8	14
First two weeks of convalescence	3	18	21
Three to six weeks of convalescence	2	91	93
Months or years	20	133	153
"During convalescence" (time not stated)	41	26	67

In the above table, the latter two may be expressed as late in manifesting symptoms only, rather than late in metastasizing in the bone.

In one case (Ebermaier) the bone disease commenced on the thirteenth day, which is very early for any type of metastasis from typhoid, as metastasis to bone and joints in most infections is in the lysis of the original infection or in advanced convalescence.

In one of Mercier's cases the onset of the bone manifestations was as follows:

Metastasis to left tibia 70th day after convalescence began.
Metastasis to left scapula 88th day after convalescence began.
Metastasis to left femur 95th day after convalescence began.
Metastasis to left humerus 97th day after convalescence began.
Metastasis to left tibia 101st day after convalescence began.

It is difficult to say whether these were metastases from a primary infection or from the secondary bone infection.

The typhoid infection is likely to be overlooked as an etiological factor, as the symptoms of the bone and joint trouble come on so long after the fever. The bacteriology clears it up. But the question arises, Is the lateness due to the quiescent bone disease or to late metastases from the gall-bladder, appendix, or intestine carriers?

PATHOLOGICAL ANATOMY OF TYPHOID OSTEITIS

The bone lesions are located in the diaphysis of the long bones and not in the juxta-epiphyseal region (metaphysis), as in the osteomyelitis of childhood or adolescence. The subperiosteal medullary layer is most often involved in the inflammatory process; then comes the intracanalicular medulla and the central medulla. The infarcts with typhoid metastases are from arrests in the smaller branches of the osseous vascular tree, of which the periosteal is the smallest.

Medulla. The marrow is softened and more or less congested, generally enough so as to be perceptible to the naked eye. Instead of the usual yellow color of the adult marrow, it varies from bright to deep red, thus simulating the hue of the marrow in the child. The quantity of fat is lessened.

Periosteum. The periosteum is thick and swollen; there is considerable injection, and it is stripped up from the bone. If suppuration ensues, there is a yellow or whitish fluid under the periosteum, sometimes tinged with red. At other times it is creamy, and even if there is no apparent necrosis of the subjacent bone, it is filled with small osseous particles. When, on the contrary, the medullary cavity is invaded by the pus, the sequestra are more abundant as well as larger.

Instead of suppuration, the osteomyelitis may undergo another transformation — in this case we have to deal with an excitation of the osteogenetic power of the deep layer of the periosteum leading to the production of hyperostosis.

Osseous tissue. The bone beneath the periosteum is more red and vascular than normal, the haversian canals are easily seen as reddish sinuosities or fine points. This appearance is due to their dilatation; they are stuffed with a reddish substance which is nothing else than the hyperæmic marrow surrounding the dilated vessels.

Dupont describes a special form seen by Tédenat. This is found after general diseases, but especially typhoid. Tédenat gave it the name of "hæmorrhagic osteoperiostitis." The collection under the periosteum is not pus, but fluid blood, as the blood infarction in the lung, which rarely coagulates. The chief characteristic of this fluid is the slowness with which suppuration takes place. Months may elapse before this comes on.

Another special form is that described by Péan. In a young girl after typhoid, exostoses developed. The bony tissue was hard, but the interior contained a cavity extending into the compact tissue, and filled with a pink, very vascular, translucent tissue resembling the fungous masses of a "white swelling." The walls of this cavity were hard and eburnated. The periosteum was thick and infiltrated (Boncour). It is a myomatous granulation tissue and resembles the œdema one sees occasionally in areolar tissue close to a focus of acute infection.

The reason for this slow tendency to pus formation is that the pure typhoid bacilli infection causes only a feeble or nil response in leucocytosis, particularly of the polynuclear variety (the same *absence* of leucocytic reaction is noted in the blood in typhoid fever — leucopenia), and therefore there is no trypsin in the field from dead polynuclear cells and consequently only a *slow* inflammatory destruction of tissue of the cold abscess variety.

W. T. Longcope made a study of the bone-marrow in typhoid fever and other acute infections. He found that in 26 cases of typhoid fever the bone-marrow showed certain definite and constant histological lesions. These resembled very closely the changes in the mesentery, lymph-nodes, and lymphoid follicles of the intestine and spleen; alterations characterized by the presence of many lymphoid cells, large phagocytes and foci of necrosis. There was more or less hyperplasia of the blood-forming cells.

The bone-marrow from 15 cases of acute lobar pneumonia, 4 cases of peritonitis, 1 of acute cerebrospinal meningitis, 1 of retroperitoneal abscess, and 1 of puerperal septicæmia, all showed the same variety of alterations, differing only in some important respects from the changes of typhoid fever.

It is possible that the lesions in the bone-marrow in typhoid fever are in some way nearly related to and perhaps responsible for the hypoleucocytosis characteristic of the disease.[1]

In 9 necropsies, Quincke found typhoid bacilli eight times in the marrow of the ribs and once in the bones of the extremities.

Fraenkel examined marrow from bodies of vertebræ in 10 cases. In each one typhoid bacilli were cultivated, but in greater numbers from the lumbar region. Was this due to the general bacillus typhosus bacteræmia, or was it due to the localization of bacilli in the osseous tissue of the spine? This is not an easy matter to prove unless there was focal destruction of the bone, recognizable by gross appearance, and an absence of the bacillus typhosus in the blood.

SYMPTOMS OF OSTEITIS

Usually the first symptom is pain. It is generally localized, but may shift from one region to another. It is almost invariably referred to the region which is subsequently

[1] Bull. Ayer Clin. Lab., 1905, January.

the seat of the necrosis or abscess. It has been likened to the osteocopic pains of secondary syphilis. The pain usually subsides in a short time, becoming inappreciable or leaving but a slight soreness.

The duration of the swelling varies. In some cases the trouble soon recurs with pain, swelling, and indications of necrosis; in others, this may be delayed for months, while again there may be repeated exacerbations and subsidences, never going on to necrosis.

There is, as a rule, *an entire absence of fever*, and the clinical course is marked by a peculiar chronicity. The symptoms at the time of necrosis are all increased — the pain becomes more severe, the surface temperature is elevated — but there are no constitutional symptoms. On incision the pain is relieved, but a sinus may continue to discharge for months or years. This is a condition rarely seen when necrosis is absent in any type of bone infection other than tuberculosis; it is common only with typhoid osteitis, and influences the treatment greatly.

The symptoms and signs of disease of the rib following typhoid are much the same as in disease from other causes, with the exception that the disease rarely if ever affects the patient's constitution. This is in great contrast to similar lesions produced by tuberculosis, pneumococcic or traumatic infections. The temperature and pulse are not raised, though there may be free suppuration. In my cases, the general health was not impaired, though disease of the cartilages, ribs and sternum, knee-joint, and long bones was often extensive. In a recent case of rib necrosis, the patient was in general robust health, though the sinuses had been discharging for months and there was very extensive suppuration and burrowing of tissue.

BLOOD CHANGES: LEUCOPÆNIA

Multiple foci. Neutrophiles, 57 per cent; large lymphocytes, 4 per cent; small lymphocytes, 38 per cent; basophiles, 1 per cent (Welz). Reds, 6,000,000; whites, 5,800; hæmoglobin, 80 per cent; polynuclears, 6.13 per cent; lymphocytes, 30.5 per cent; mononuclears and transitional forms, 7.5 per cent; mastzellen, 0.5 per cent (Bernert).

Spine. Leucocytosis, 17,400 (Frick); leucocytosis, 17,600; polynuclears, 84 per cent (Conner); leucocytosis 10,400 (McCrae, Case I); blood normal (McCrae, Case II).

In one of our cases in which the ribs and long bones were involved the blood gave a leucocytosis ranging from 6,200 to 10,400. The blood changes in the absence of the bacillus typhosus are not pathognomonic. In one of our recent cases of spinal infection, bacilli were found in the blood, but they were also present in the urine and fæces and in the gall-bladder and appendix. They, therefore, may have arrived in the blood from any of the other habitats as well as from the bone focus.

X-RAY FINDINGS IN BONES (EXCEPT SPINE)

Multiple foci. Three years after extrusion of sequestrum, the inner surface of the radius was seen to be irregular and the curve much increased. The ulna was markedly affected; there was irregular osteoperiosteal thickening and at the upper one-third a clear notch corresponding to the eliminated sequestrum (Laignel-Lavastine).

Ulna. Marked rarefaction with osteitis in upper one-third (Tubby-Hicks). Spindle-shaped thickening in middle of shaft (Welz).

Femur. Thickening in lower one-third (Jensen-Kock).

Tibia. Radiogram showed quite clearly rarefaction at the site of swelling, and a rarefied tract running across the bone at the upper end, about one-fourth inch wide and apparently ending below the periosteum (Lilienthal). Central erosion joining upper and middle thirds of right tibia, with marked cortical sclerosis and periostitis, the sclerosis extending for about six inches (Gilbert). Osteomyelitis of epiphysis (Churchman). Much osteitis and periostitis and narrowing of medullary canal, but no evidence of "shirt-stud abscess" (Rolleston).

The simplest process is a localized bone abscess, sometimes three or four in the same bone, in the cortex just below the periosteum. These show in the X-ray as a rounded loss of substance, casting a shadow of different density than the normal bone. They are generally small, about the diameter of a

lead-pencil. The bacillus has been recovered from such conditions, showing that they are true infections and not simply bone cysts. The periosteum may become involved and the process may spread so that the X-ray will show more extensive involvement of the cortex. The X-ray picture *per se* is only rarely indicative of the pathological cause, though it usually shows decided bone changes. The *limited area* involved is suggestive of the diagnosis and, if supported by a history, makes a good lead to the etiological factor.

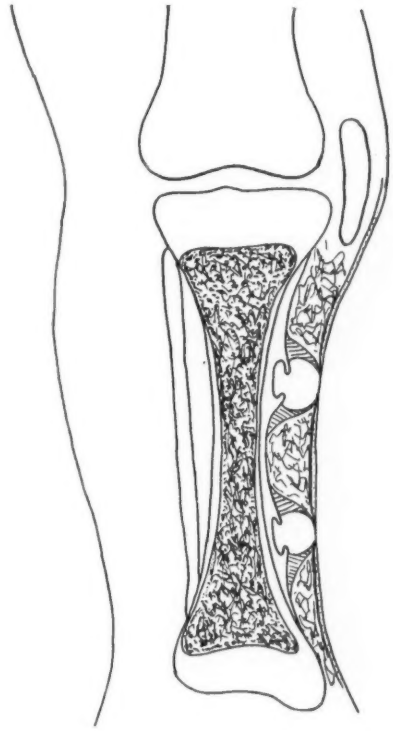

FIG. 1. Schematic drawing of "shirt-stud abscess" (Pean and Cornil). The swelling rises about 0.8 inch above the tibial crest. It is hard, bony; the skin is thinned and the periosteum thickened and lifted up. In the thickness of the periosteum is an inflammatory focus, the tissue infiltrated with small round-cells. The compact tissue of the diaphysis has a cavity containing embryonic marrow and limited by eburnated walls; this does not involve the medullary cavity. These cavities communicate with each other, forming a "shirt-stud abscess."

SEARCH FOR BACILLI IN FÆCES

Juergens gives a most instructive account of the post-mortem examination of two cases at Trier. In the first case, the fæces had been examined without positive results for six days before death, which occurred in the second week of the disease. A half hour after death, the intestine was carefully searched. In the duodenum there were innumerable typhoid bacilli, and the bile also swarmed with them. In the lower ileum, where there was marked swelling of the lymphoid tissue, there was a distinct decrease in the number of typhoid bacilli. In the colon they were again greatly increased, but they were nowhere else so numerous as in the duodenum, and it is conceivable that in any given mass of fæces they might be absent.

A similar result was obtained in a case fatal from typhoid in the beginning of the fifth week.

We may, therefore, learn from further investigation why the examination of the fæces yields positive results in only 60 per cent of the cases. From the practical point of view a note of the time necessary for an examination is of interest. Twelve hours may be allowed for the development of the characteristics of the bacillus and its colonies on the plates. Likely colonies should then be planted in glucose agar, and cultivated for twelve hours in order to ascertain whether or not there is an absence of fermentation, and at the same time a broth cultivation of the colonies should be tested by typhoid-immune serum of great potency, for the reaction of agglutination at a high dilution. These observations afford the main elements in a rapid detection of the bacillus, and they can be fully made in about twenty-four hours.

In the acute cases the blood and urine should always be repeatedly examined for bacilli, and a diligent, careful search is frequently rewarded by success.

There has been no definite relationship established between the findings of the bacillus in the fæces and blood and the secondary manifestations in the bones and joints, although Lilienthal reports the case of a carrier with multiple lesions six years after the typhoid.

The patient, a male, aged 27, had had typhoid in 1904. During convalescence from the disease, he developed osteomyelitis of the left clavicle, right radius, lower left tibia, and one of the right metacarpal bones. All healed under surgical treatment. At the same time there was a red and painful swelling over the upper right tibia, which disappeared without perforation of the skin and without operation. In September, 1910, six years after the original typhoid infection, the middle of the right tibia became swollen and very tender, so that the patient was unable to work. He was admitted to the hospital October 15, 1910. An X-ray showed quite clearly rarefaction at the site of the swelling and a rarefied tract through the bone, about one-fourth inch wide and apparently ending below the periosteum. The highest temperature was 100°. At operation a piece of bone about three by three and three-fourth inches was raised like a lid, disclosing a lake of blue pus. The cavity was disinfected with formalin, dressed by Schede's blood-clot method, and three months later it was quite well. A pure culture of typhoid bacilli was obtained from the pus.

Unfortunately, the stools and urine were not examined, but from the findings in other similar cases we know that the bacilli are not necessarily present in the secretions or excretions of those suffering from old typhoid lesions. This man was a typhoid carrier, but probably not a disseminator of the disease — a distinction which should be more generally recognized.

W. R. Gore reports a case of post-typhoid necrosis of the frontal bone and intracranial abscess eleven years after typhoid fever.

The patient was a man, aged 39, who had had typhoid in 1900, during the Boer War. His was one of the worst attacks recorded at the time. Four years ago, an abscess developed over the lower third of the femur which was incised and healed. It reformed and was found to communicate with the interior of the bone. It was operated on again and this time it took eighteen months for it to heal. No bacteriological examination was made at first; later the cultures showed streptococci and staphylococci. In the winter of 1910 the patient had three attacks of illness, the first one in November, each lasting about a week, with a month's interval. The symptoms were the same in each attack — headache, rigors, profuse sweating, and fever of 105°; then complete recovery. This patient was seen by Gore on July 17, 1911, for a similar attack. On the fourteenth day a small swelling was found in the scalp over the midfrontal region. Pus obtained from this swelling by a hypodermic needle gave a pure culture of typhoid bacilli. The abscess was opened and found to be intracranial; the frontal bone had a hole about three-fourths inch wide and communicated with a cavity between the dura and the bone. There was no dead bone. At the time of the report the sinus leading to the dura still persisted.

I may take it that these cases are typhoid carriers, the habitat of the bacilli being in the walls of the gall-bladder, where they cannot be reached by medication or vaccines, as they are shut off from the circulation, but from which situation they can occasionally infect the blood stream. Removal of the gall-bladder has been proposed and performed, but the operation in these cases appears to be a dangerous one. The other alternative appears to be to try vaccines. I had an autogenous vaccine prepared, and the largest dose I was able to give was 500,000; larger doses produced too much reaction, showing great susceptibility. The pus of the abscess at first gave a pure culture of typhoid bacilli; now this has disappeared and the pus contains staphylococcus albus only. Widal reaction to 1 to 200 only.[1]

Davies Hall and Riberts report the case of a typhoid carrier.

A woman, aged 39, had typhoid in July, 1905. The fæces and urine were examined daily for fifteen months. No mention was made of osteitis. In December, 1908, typhoid bacilli were found in the urine. By April 15, 1909, they had disappeared. January 4, 1910, they reappeared in the urine and remained until February 27, 1910. Since that time the bacillus coli has been found, but not the typhoid bacillus. November 8, 1913, the urine was still free from the typhoid bacillus.[2]

We have looked up references to 20 other cases of typhoid carriers, including "Typhoid Mary," and find no specific relationship between these and cases of osseous and joint disease. One was in a man who had typhoid forty-five years ago, with positive cultures from the fæces. No mention of bone or joint lesions was made in his case.

The viability of the bacilli in old bone-abscess cavities years after the attack is a striking feature of this infection, and when opened in operations may start an acute virulent process in the fresh area of the operation wound.

Taylor reports the case of a man, aged twenty-three years, who was ill with typhoid for three weeks. He had no relapses and no complications. Two years later he had a second attack of typhoid, which was more severe than the first attack, although con-

[1] Proc. Royal Soc. Med., 1912, v, Surg. Sec., p. 1.
[2] Lancet, Lond., 1910, September 3.

valescence was more rapid. About five weeks after the onset of the second attack, a periostitis of the tibia developed.

Following are a few interesting cases:

Aloin reports the case of a female, aged 20, who had a prolonged attack of typhoid fever from June 1 to August 20. During convalescence she had a slight attack of cholecystitis. She had had apyrexia for three weeks when the first abscess developed. Bacilli in this case persisted in the blood for a year.

Tubby and Hicks report the case of a male, aged 25, who developed a lesion in the ulna thirteen years after an attack of typhoid fever. A pure culture of the bacillus typhosus was found in the pus, but there were no bacilli in the fæces or urine.

In 2 cases reported by Bryan, infection of the ribs was diagnosed as "liver abscess."

Potter, in 1889, reported 3 cases which he attributed to the use of large doses of antifebrin during the course of the fever, which was probably erroneous.

Male, aged 40, had typhoid fever when twenty years old, lasting five and a half months. Three weeks after the onset of the fever there appeared on the lower left thigh a red and painful swelling, which subsided slowly. During the next twenty years he had pain from time to time, but not sufficient to cause him to cease work. In October, 1908, he had a trauma to the thigh, which was followed by pain and a fever of 102.2°. Finally a swelling, about the size of the palm, formed in the original location, above the condyle. Fluctuation was well marked, but it was not very tender. The femur was evidently thickened. An incision was made and an abscess found leading to the bone, which was denuded. The bone was trephined, but no cavity or sequestrum was found; simply a sclerosis. Fistula remained open for several months and then closed. The pus was found to contain the bacillus paratyphosus.

Rolleston reports the case of a male, aged 32, who had had an attack of typhoid eleven years previously, with thrombosis of the left femoral vein. Since then he has had attacks of pain and swelling at the junction of the middle and the lower thirds of the left tibia every spring and winter. Each attack lasts about three weeks, and there is no discharge of pus or perforation of the skin. The Wassermann and Widal are both negative. The swelling is red, painful, œdematous, and about the size of a hen's egg. There is a small soft area in the middle suggesting the "shirt-stud abscess." At this point the leg is a half inch larger in circumference than its fellow. The swelling subsides under rest and lead applications. The X-rays showed much osteitis and periostitis, with narrowing of the medullary canal, but no evidence of a "shirt-stud abscess."

Spencer reports the case of a boy who after an attack of typhoid had recurrent attacks of pain in the tibia. Subsequently a "shirt-stud abscess" formed in the tibia and healed after surgical treatment. Later, eight or nine years after the typhoid, he was readmitted with general peritonitis. Necropsy showed typhoid necrosis of the lower end of sternum, and an abscess had burst into the peritoneal cavity. There were no chronic ulcers; only healed scars in the ileum. Typhoid bacilli were obtained from the "shirt-stud" abscess, but not in the pus from the peritonitis.

Fuerbringer reports the case of his son, who had seven attacks in ten different bones.

Mercier refers to a case with six attacks in six different bones.

The above cases are cited for the purpose of calling attention to the varied manifestations of the disease. With this picture before one, the importance of positive lines of treatment of the earliest manifestations of typhoid osteitis and periostitis is accentuated. With these varied pictures in mind, one is impressed with the importance of making a careful bacteriological examination of every case of bone or periosteal abscess, in order to determine the definite etiologic factor in the case.

TREATMENT OF OSTEITIS

The local treatment of osteitis consists in the opening, trephining, scraping, draining, disinfecting, and washing out of the cavity, first with 5 per cent phenol and then with a 1:1000 solution of the hypochlorite of calcium and water, with immediate closure without drainage, so as to avoid a mixed infection, as that greatly retards the process of repair. When there is a necrosis, all of the sequestrum must be removed and the cavity laid open extensively from one end to the other, so that one is assured of the complete removal of all of the necrotic tissue. *Failure in this particular is the most common cause of protracted discharge from osteomyelitis and bone infection diseases of all types.* Wherever there is a periostitis, osteitis should be suspected and the bone cavity explored with drill, trephine, or chisel, as the case indicates. Many times with subperiosteal pus accumulation an invisible sinus exists which leads to a focus of necrosis or suppuration. Overlooking this is disastrous to the result of the operation. The sinus tract should be excised down to the bone, so as to give a fresh, healthy wound surface for subsequent union,

FIG. 2. Case 1. Radiogram showing distinct focus in the superior articular surface of the second lumbar and in the inferior surface of the first lumbar vertebra. These lesions are identical with those appearing in the long bones, due to the same infection, and result from an actual loss of bone substance (Rogers.)

and afford a favorable condition for subcutaneous approximation of the soft parts with iodine catgut. The skin is best approximated with clips, so as to produce a large surface contacting and thus favor primary union.

Whenever cicatricial bands exist in the subcutaneous tissue they should be divided so that there will be little or no tension on the subcutaneous and cutaneous stitches. These retracting bands often tend to separation of the wound edges subsequent to the closure.

All of the bleeding must be controlled by pressure before the wound is closed. A large blood-clot under tension is unfavorable to primary union. When the blood-clot is not under great tension and when it is sterile it is favorable to the process of repair, after the plan of Schede. The reason the Schede treatment sometimes fails is because the hæmorrhage is not sufficiently controlled before the wound is closed. If one cannot stop the oozing from the bone, then a current of hot air, such as is used by the dentists, should be applied to the surface, or a tampon of very hot salt solution should be packed into the cavity.

The careful sterilization and preparation of the cavity is very essential to a smooth course after the operation. In this, as in all lines of bone work, sufficient care in the sterilization of the bone cavity is not exercised, which accounts for some of the suppuration that occurs after opening and cleansing pus pockets in bone. Where these large cavities exist it would be desirable to transplant bone from other positions in the body, but this is not justifiable under our present methods of sterilization of these cavities, as the transplant becomes a foreign body and does not offer the same resistance to the pus microbes that remain in the cavity that a blood-clot would. There have been reported in the literature a number of cases of acute spreading osteomyelitis, following the extraction of sequestra and curettement of bone cavities. Why this should occur in some and not in others is not explained.

Drainage should never be used in these cases, where one feels fairly sure of efficient sterilization. Once a drain is inserted into a bone cavity, secondary filling of the bone cavity must be relied on for repair, and we all know that this is a very tedious process, taking sometimes months and years, depending on the size and conformation of the cavity.

In the case in which there is deep swelling without impending perforation, rest and elevation of the limb, if in the lower extremity, and constitutional treatment with typhoid vaccines, is the proper procedure. The dose of vaccine should be comparatively small to begin with and rapidly increased to larger doses, depending on the patient's tolerance. By following this method many of the cases will be hastened in their course to recovery without surgical intervention. If one wishes to make an autogenous vaccine, puncture should be made under the proper precautions and the material from the puncture withdrawn for the purpose of making the vaccine. In this way suppuration can be aborted or the infected focus rapidly cured. The injection of an autogenous vaccine autosensitized (Murphy) has a decidedly ad-

vantageous effect on the process of repair. If an autogenous vaccine cannot be secured, a stock vaccine may be used, although the reaction may be rather severe and annoying. The injections should be made beneath the periosteum as close to the suppurating focus as possible. One should start with 50,000,000 dead bacilli and then increase as rapidly as possible. When one uses the autosensitized vaccine on the plan originally worked out by us, very much larger doses may be administered than when the ordinary vaccines are used. The effect on the suppurating foci in the bone, subperiosteal zone, and joints is in striking contrast with the effect produced on the carriers of typhoid bacilli. In the bone and joint disease, the vaccine material is carried through the blood directly into the infective foci, while in typhoid gall-bladder infections it is carried only to the mucous surface and does not come in contact with the micro-organism. In the former the typhoid bacilli live in the tissue; in the latter they are on the mucous surface.

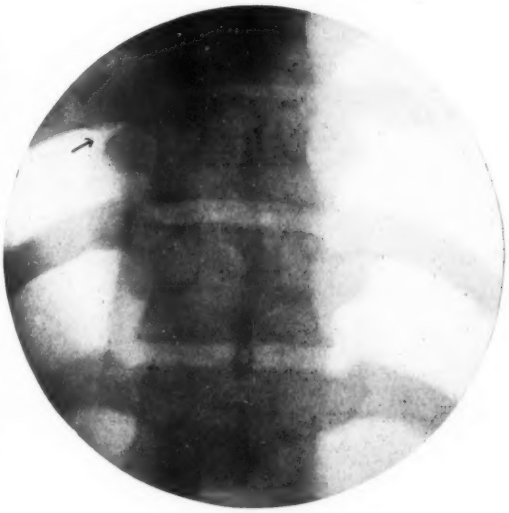

FIG. 3. Case 2. Arrows indicate similar lesion as in Case 1. In this case the lesions show on both sides of the superior surface of the tenth and the inferior surface of the ninth. (From the X-ray Department of the Massachusetts General Hospital, W. J. Dodd, M.D., roentgenologist.) (Rogers.)

In the treatment of typhoid perichondritis, periostitis or osteitis, opening and curetting has been the usual course followed up to this time. The results have been exceedingly bad, in that the cases are not cured by this line of treatment. What should be done is a large flap operation, exposing all of the costal cartilages and sternum on the side involved, or on both sides, as indicated in the schematic drawing. The cartilages and bone involved should be laid bare, and when a cartilage is involved, no matter whether it is a shirt-stud involvement or an extensive involvement, *all of the cartilage should be removed*, with at least a half-inch of the bone of the sternum at its attachment and from the rib at its attachment. It is unnecessary to dissect out the perichondrium or periosteum. The granulation tract should be carefully cauterized or dissected. This should be done with each succeeding cartilage until one is entirely beyond the infected zone. The sinus tract in the soft part should be dissected out, all granulation tissue removed, the hæmorrhage fully controlled by hot air, hot water, or cautery. As much care should be exercised in the disinfection and preparation of these cavities as a dentist exercises in preparing a tooth for filling. Until we arrive at that degree of perfection we will not be very successful in securing primary union and sterile blood-clot formation for repair. One must realize that unless superlative asepsis is attained it will result in failure. One should also appreciate that when superlative asepsis is attained a very great and prolonged invalidism is avoided.

When the bone cavity is deep and large it may be necessary to cut down the margin of the cavity, so that only 60 or 70 per cent of the bone remains intact, in order that the soft parts may fall in and aid in filling in the cavity. The use of the Moorhof or Moore plugs is advisable in cases that do not admit of an assumption that primary asterile blood-clot repair can be attained.

In all of the cases with sinuses, where one is not able to do a primary closure, it is desirable to pack the wound with gauze saturated with a 1:1000 solution of hypochlorite of calcium. This should be renewed every twenty-four hours for four days, at which

time it may be discontinued. The hypochlorite of calcium is the best disinfectant for the typhoid bacillus sinus and for the colon bacillus groups of infections.

REPORT OF CASES

Rosenberger reports the case of a man, aged 40, who had typhoid fever on December 31, 1909. In two weeks he had pain about the seventh rib on the left side; six weeks later a swelling appeared at that point, about the size of a silver dollar, which lasted for several months. About October 15, 1910, this opened spontaneously and discharged a fluid, mostly serous, but at times bloody and purulent. December 13, 1910, typhoid bacilli were isolated. A vaccine was made and the first injection of 1.5 ccm. was made on December 23. In twenty-four hours the patient had fever, pains in his head and back, malaise, great local swelling and discomfort, just as in the original attack of typhoid — a common train of symptoms following large doses of all types of vaccines. The fistula closed after seven injections of the vaccine.

Sharpless also reports a case in which vaccines were used. His patient was a man, aged 32, who a month after convalescence from a typical attack of typhoid fever experienced a tender and swollen area at the middle of the right tibia, which gradually extended until it was within an inch of the tubercle. An injection was made of 90,000,000 dead bacilli into the right ankle, and ten days later 180,000,000 were injected. Following this second injection there was intense local reaction, swelling of the entire leg below the knee, fever of 102°, and great pain. The injections of 180,000,000 were continued at ten-day intervals, and in four months the man was practically well.

Keen reports a case in which the right sixth and seventh costal cartilages were involved following an attack of typhoid fever. An incision was made, which closed gradually, though the swelling persisted. About sixteen years later (July, 1894) the swelling was incised and a portion of one rib removed. The sinus persisted and another operation was performed in October, 1894. In January, 1895, the patient was operated on by Morton, the wound never having healed. A portion of the sternum and of some of the ribs was removed, without cure. February 20, 1895, Keen made an extensive flap operation, taking out between three and four inches of the fifth, sixth, and seventh ribs, which were softened from osteomyelitis. The wound closed, but later reopened with a sinus to the sternum. On March 25, 1896, Keen removed more of the diseased bone, and complete healing finally took place, though very slowly.

Harzbecker reports a case of rib and cartilage involvement after an attack of typhoid fever. An incision was made June 1, pus was evacuated, 0.8 of an inch resected, but the fistula persisted. October 3, the cartilages of the sixth, seventh, and eighth ribs with adjacent rib ends and part of sternum were removed; healing was slow. June 27 of the following year the fistula was scraped. Final healing took place twenty-six months after the first operation and three years after the typhoid fever.

Bristow reports a case in which five operations were performed in two years.

TYPHOID LESIONS OF RIBS

Keen, in his work on "The Surgical Complications of Typhoid Fever," states that the ribs and cartilages are affected later than the bones of the extremities, etc. This is corroborated by the following figures:

BONES IN GENERAL

Spine	Other Bones	Total
24	76	100
21	100	121
14	51	65
12	54	66
..	17	17
71	298	369

RIBS

Age	
Less than 20 years	1
20 to 30 years	9
30 to 40 years	15
More than 40 years	28
"Adult"	4
	57

The 57 ribs are included in the 298 bones. Of 533 bone lesions, 19 were multiple and 136 were in ribs.

LOCATION OF LESIONS IN RIBS

	Unilateral Right	Unilateral Left
1st	1	1
2d	..	..
3d	3	1
4th	1	..
5th	10	..
6th	11	5
7th	4	9
8th	3	6
9th	3	1
10th	..	..
11th	..	..
12th	1	..
	37	23

	Bilateral
Right 3d and 5th; left 7th and 8th	1 case
Right 5th and 6th; left 6th and 7th	1 case
Right 7th; left 6th	2 cases
Right 3d, 4th and 5th	1 case
Right 6th, 7th and 8th	1 case

Of 5 cases of infection with paratyphoid, 1 was in ribs.

FREQUENCY OF TYPHOID SPINE

In 6,905 cases of typhoid fever, only one of typhoid spine was observed by Halpenny and Meyers. From this statement one is not justified in assuming that only one case resulted from this large number of cases, as many may not have shown symptoms until months or years after the patients left hospital.

FIG. 4. Typhoid spine, showing the limitation of the process to the region of the disk, and the deposit of new bone (indicated by arrow), between the transverse process (Silver). This case rather indicates a panspondylitis, in which the bone, the disk, the periosteum, and the perichondrium are all involved.

AGE AND SEX INCIDENCE

Males, 92; females, 16. Note the great disparity in the sexes. The great frequency in the male may be accounted for by his early return to activities and his excessive exposure to trauma and occupational continued pressure on segments of the spine in his work.

10 to 14 years	5 cases
15 to 19 years	19 cases
20 to 24 years	6 cases
25 to 29 years	15 cases
30 to 39 years	14 cases
40 to 49 years	10 cases
More than 50 years	2 cases
	71 cases

Extremes: A boy, aged ten years, and a woman, aged sixty years.

These figures are included in the general bone lesions, age and sex.

LOCATION OF DISEASE IN THE SPINAL COLUMN

Cervical	1
Dorsal	8
Dorsolumbar	10
Lumbar	59
Lumbosacral	6
Sacral	4
	88

It will be noted that the dorsolumbar and lumbar regions are most commonly affected.

FIG. 5. Case 1 (typhoid spine). Typhoid, July 23, 1904. Spinal pains third week. In plaster jacket, October, 1904, to December 15, 1904. X-ray, February 26, 1907. No intervertebral space between 2 and 3. Kyphos visible and palpable at second lumbar vertebra (Myers). It looks as though ossification had taken place in the intervertebral disk, which is not an uncommon late manifestation of typhoid, as well as other types of spondylitis.

Here is where you have the greatest latitude of motion and the most frequent traumas, and the greatest opportunity for continued occupational pressure, either in the sitting or standing position. Probably the lumbar region is more vulnerable to strain and subjected to greater pressure during convalescence than the regions higher up. The upper lumbar region seems especially liable to attack. Silver has suggested as additional reasons for this the greater amount of cancellous tissue; *i. e.*, a greater amount of suitable nidus for the bacillus in this locality, and the possibility of direct infection from the lumbar lymph-nodes. This latter hypothesis, however, we do not consider valid. The lumbar

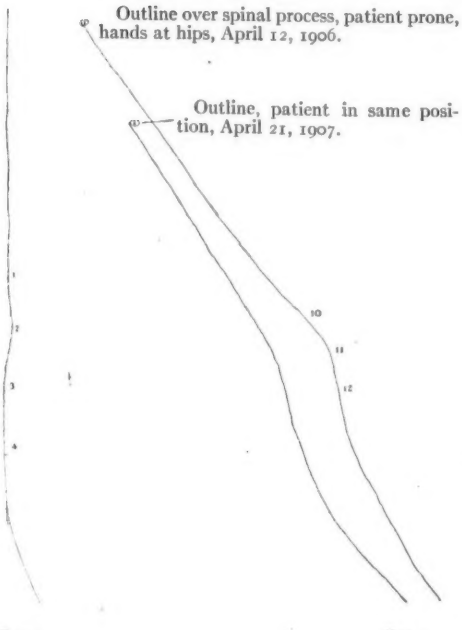

FIG. 6. Spinal tracings. (Myers.)

zone suffers most from pressure in the sitting position during the convalescence stage of the disease.

SYMPTOMS OF TYPHOID SPINE

The onset is generally insidious, without any marked elevation of temperature or any general reaction. The pain develops slowly, so that the patients are able to walk for a more or less long period of time. When in the lumbar or dorsolumbar region the symptoms consist of lumbar pain, together with accompanying pain of variable distribution — in the groin, abdomen, hip, or lower limbs — the common reflex pains of metastatic spondylitis of many infections. There is stiffness of the spine with disappearance of the normal lordosis in the lumbar region. Pressure is painful over the spines of the bodies involved in the infection and in front over the bodies; occasionally there is pain over one of the nerves passing out of the foramina of the zone involved, most commonly the sciatic. Quincke considered œdema of the lumbar region a typical sign of the affection, but it was wanting in the 5 cases seen by Josephovitch.

The sensory disturbances consist of hyperæsthesia, girdle sensation, incontinence, and rhythmic contraction of the abdominal muscles. In some cases there are nervous phenomena — radiating pain, spasm, patches of hyperæsthesia and abolition of the patellar reflex. These phenomena present themselves as symptomatic of genuine radiculitis, and by their anatomical location correspond to their respective spinal roots, most commonly the second, third, and fourth lumbar roots, which is in accord with the topography of the bony lesions. What is the cause of this radiculitis? Is it, as Quincke believes, from compression of the roots at the spinal foramina by the proliferation of the periosteum; or, as claimed by Virchoubsky, that there is an extension of the osteoperiosteal inflammation to the neighboring meninges? A study of the lesions as revealed by the X-ray corroborates Quincke's belief, and corresponds to the pains of other spondylitic disease and injury pains due to radicular pressure, and is always increased by forced flexion, extension, or lateral motion, depending on the location in the particular bodies of the vertebra.

Of the reflexes, ankle-clonus was found present in 6 cases, increased knee-jerk in 19, diminished knee-jerk in 4, Kernig in 2, and Babinski in 1.

Deformity was present in 17 of 59 cases, usually a mild kyphosis involving one or several vertebræ. In 3 cases the deformity persisted after recovery. There was one instance of lordosis and a few of scoliosis. The deformity indicates that it is the anterior portion of the bodies that is most commonly involved, and this is the part that is most frequently and continuously subject to pressure in the sitting and working positions.

As to the method of production of kyphosis, Wullstein is of the opinion that it is due to grouping of the bacteria toward the anterior portion of the bodies, with subsequent absorption of bone and development of deformity. As often noted, kyphosis appears much too early, acutely and rapidly, to

be explained thus, and the study of radiograms of these cases suggests that it is rather the result of periostitic changes, with softening of ligaments and disorganization of one or more intervertebral disks. What is actually observed is disappearance, more or less complete, of an intervertebral disk with approximation and synostosis of the vertebral bodies above and below it; and as our studies elsewhere show, a solution and disappearance of the disks, especially in a normally lordotic region of the spine, leads to kyphosis. In these particular cases the prolonged recumbency, muscular wasting, and ligamentous relaxation of typhoid fever are all in favor of obliteration of the lumbar lordosis. In fact, a perispondylitis, with œdematous softening of the spinal ligaments and disorganization of the disks, is sufficient to account for the local signs.

The presence of bacilli in the vertebral bodies has been abundantly proved. Naturally their number and virulence and distribution vary, and correspondingly the microscopic signs vary, due to the reaction of the invaded tissue. Thus more or less increase of the leucocytes, giant cells, presence of blood extravasations, and a network of fine fibrin filaments enclosing necrosed cells and débris may be observed. That is, the typhoid patient must often be on the verge of spondylitis, and a little strain or trauma alone is needed to turn the scale. The macroscopical evidence or clinical manifestations vary in proportion to the location, extent, and acuteness and chronicity of the process in the respective spinous bodies or their coverings.

The following description, from Cutler, illustrates the spinal involvement: This patient, to raise from stooping, has to aid himself by his hands on his knees and thighs. The fixation of the spine is one of the earliest and most pronounced symptoms of typhoid spinal disease, but it is also the most common — in fact, an almost universal symptom of every type of spondylitis. In farming communities there is a regular crop of spondylitides, occurring after the late harvesting work in corn, potatoes, and fruit. These patients, however, do not complain so frequently of the spine as they do of the radiating pains in the abdomen, and particularly in the sciatic nerve region. These cases are commonly diagnosed as lumbago, sciatica, chronic appendicitis, duodenal ulcer, etc., when the real lesion is a spondylitis with radicular reflex pains. An examination of the spine reveals the true disease through its fixation.

X-RAY FINDINGS OF TYPHOID SPINE

Rogers cites 2 cases in which he gives the X-ray findings. In one there were 4 distinct bone foci, 2 on the upper surface of the second lumbar vertebra, and 2 on the lower surface of the first lumbar. They were all about the size of a lead-pencil, circumscribed, rounded, showed a distinct loss of bone substance, and resembled very closely the typhoidal lesions of other bones, both in shape and location. In the second case there were also four distinct lesions, at the tenth and eleventh dorsal vertebræ, with a similar punched-out loss of substance. The location of the lesions corresponded to the points of tenderness at the border of the ribs.

Cutler, Chatin, and Peltesohn report that in their cases there were no changes to be seen by the X-ray.

McCrae reports 2 cases in which radiograms showed deposits of new bone.

Myers's case showed a lack of clearness of intervertebral interval, as did also the case of Silver's.

Cannon and Lovett report distinct changes in their cases, while Fichtner reports actual bone destruction.

Josephovitch reports 4 cases. In all, the lesions were located at the third and fourth lumbar, while the second and fifth appeared intact. The maximum changes were to be seen in the intervertebral disk; here there was marked wasting, with narrowing or complete disappearance of the intervertebral interval, so much so that the two vertebræ appeared to be in contact. The changes in the bony tissue were much less marked, and most in evidence in the parts immediately adjacent to the intervertebral space. Often, though not in all the cases, there was ossification of the periosteum and ligaments of

the spine. None of the cases showed any destructive process in the bodies of the vertebræ.

These changes are already evident in radiograms taken soon after the onset, say in thirty-six hours. As a result of this X-ray study the term "spondylarthritis" is a more appropriate term than osteitis. It will be noted in the above that the group of surgeons, well known as consultants, cited cases of actual bone foci. That is just the class of cases that would come under the observation of such consultants. The milder cases of periostitis and perichondritis show no X-ray manifestations of the disease. In fact, the X-ray has little or no value in the diagnosis of the average case of typhoid spondylitis. In our experience the plates come back almost always with a negative report, while the clinical findings of the disease are superlatively positive. The diminution of the thickness of the intervertebral disk is one of the most frequent signs recognizable in the X-ray.

Potter, one month after the onset of the disease, noted a very definite lesion in the disk between the tenth and eleventh dorsal vertebræ. The space between these two vertebræ was about half the normal size. The contour of the upper surface of the eleventh dorsal was indistinct on the left side. Three months later the spacing between the tenth and eleventh dorsal vertebræ was much less than between the other vertebræ. The edges were not so clear-cut as above and below, and there was increased density of the lower part of the tenth dorsal and upper part of the eleventh dorsal.

DIFFERENTIAL DIAGNOSIS OF TYPHOID SPINE

Diseases most likely to be mistaken for typhoid spine are neurasthenia, tuberculosis of the spine, and lumbago. Lumbago is transient and apt to recur. In typhoid spine there is no immediate relief from fixative appliances as in tuberculosis. In some instances they seem primarily to aggravate the symptoms, but if continuously applied greatly relieve them. There is nothing so unsatisfactory as trying to relieve neurotic symptoms by fixation. Even if we obtain temporary relief, relapse is certain. The pronounced relief from fixation and the absence of recurrence is the strongest evidence that typhoid spine is not a neurosis, as claimed by Osler.

TYPHOID SPONDYLITIS AND SPONDYLITIS DEFORMANS

In typhoid spondylitis certain local changes may be seen, such as redness and swelling. There is an œdema and swelling of the perichondrium and periosteum and finally a thickening of the periosteum, which, we believe, accounts for the pressure on the nerves in the spinal foramina and is the greatest causal element in the production of the radicular pains. This perichondrial and periosteal thickening can be easily recognized through the X-ray on thin and young patients. The changes in the angles of the spine, lateral or lateroposterior, cause great increase in the pain, due we believe to the increased pressure on the nerve-roots in the foraminal tracts. The relief which is obtained by immobilization should also be estimated on the same basis. In the legs we have changes in the reflexes and sensation, with probable wasting, which speak, however, for an organic change in the spine. There is without doubt in some cases a bony deposit, but we cannot say that in all cases we have an organic change. The typhoid lesion involves usually only one or two and rarely as high as four bodies. This bears a close resemblance to the area involved in tuberculosis, but contrasts markedly with the extensive involvement in metastatic arthritis.

The clinical picture of spondylitis deformans is similar to the typhoid spondylitis — the same marked neurotic condition, the same tendency to get well, but with more severe symptoms. In fact, a fairly exact parallel can be drawn between the two. In the arthritis deformans all conditions exist from that in which the whole spine is involved to that in which there is only a small local lesion and very little pain. A similar condition occurs in typhoid spondylitis, but the lesion is usually very circumscribed, while in the other types of metastatic spondylitides, often called rheumatoid, the lesion may be very extensive.

TREATMENT OF TYPHOID SPINE

The treatment of typhoid spine should be, first, its prophylaxis. Severe pain in the back in the third or fourth week or at any time in the convalescence should be immediately recognized as an indication for prophylactic treatment. The prophylactic treatment consists in placing the patient on a rigid bed or cot and insisting on the maintenance of a position of absolute horizontal rest until all of the soreness and acute pain in the spine disappear.

Then an autosensitized autogenous vaccine should be administered. The culture may be obtained from the blood, the urine, or the fæces. If an autogenous vaccine cannot be secured, then stock vaccines should be used.

Once the spinal symptoms have appeared the patient must be protected from trauma, that is, from flexion or extension of the spine, for a number of months by a properly fitted sole-leather jacket, which is far superior to a brace and more comfortable than a plaster-of-Paris jacket. Following this plan, patients are early relieved of their symptoms and prolonged invalidism is avoided. They rarely if ever form abscesses or demand operation. The radicular pains may persist for a considerable period of time, until absorption of the periosteal and perichondrial exudates has been accomplished. Relief of these pains is best obtained by the coal tar preparations. *Opiates in any form should be avoided from the beginning*, as these cases often have a chronic course and once the opiate is started it is almost impossible to discontinue it, and the patient eventually becomes a drug habitué. In addition, relief is not obtained as rapidly nor is it as lasting as when the coal tar products are given — acetanilid, antikamnia, antipyrin, and aspirin.

Some years ago, Virgil Gibney, to whom we owe a debt of gratitude for first recognizing and describing the disease, advocated the use of the actual cautery. Josephovitch in one of his 5 cases had good results from douches of dry air to the pelvis and lumbar regions.

As a final result, permanent fixation with ossification is not an uncommon observation. As soon as this has taken place, there is a rapid relief of the radicular and reflex pains.

FREQUENCY OF TYPHOID ARTHRITIS

There were 14 cases of joint lesions in 5,299 cases of typhoid fever (five authors).

Sex. Males, 20; females, 18 in 38 cases. In others sex not stated.

Age less than 20	46
20 to 30	3
30 to 40	2
More than 40	1
"Adult"	2

According to Keen the great majority are under twenty years of age, which is in contrast with the age of the pyogenic metastatic osteitic manifestations, and still more marked with the rib and costal cartilage manifestations.

Varieties. Polyarticular, 11 cases; arms and legs, 3; legs, 6; arms, 2. Monarticular, 95 cases; pelvis, 1; legs, 70; arms, 17; and both arms and legs, 7. *There was spontaneous dislocation in 51 cases, 48 of the hip.*

The bacteriological examination of 7 cases revealed a pure culture of typhoid bacillus in 3, pus microbes only in 1, and 3 were sterile.

Keen recognizes three forms of typhoid arthritis:

A. Rheumatic.

B. Septic.

C. Typhoid, properly so-called.

A and B may be single, though they are generally polyarticular. B is generally a mixed infection, with pyogenic cocci.

According to Robin and Leredde, acute articular rheumatism may be complicated by typhoid. As we interpret this, a metastatic arthritis other than that caused by the bacillus typhosus may precede or accompany a typhoid joint infection. Multiple infections in the early days of exanthematous diseases are very rare.

DATE OF ARTHRITIS MANIFESTATIONS AS COMPARED WITH ONSET OF TYPHOID

1st week of typhoid	2 cases of arthritis
2d week of typhoid	8 cases of arthritis
3d week of typhoid	8 cases of arthritis
4th week of typhoid	17 cases of arthritis
More than 4 weeks	4 cases of arthritis

It will be noted that metastatic arthritides of typhoid occur in the early days of convalescence; that is, after the subsidence of the acute manifestations of the disease. This is in consonance with the metastatic ar-

thritides of all types of infections except the streptococcic variety, to which we called attention in 1904.

The arthritic manifestations resemble at their onset any other acute joint inflammation. Pain if in the hip radiates down the thigh, and is often most severe at the knee-joint (which is explained on the line of nerve reflexes accentuated by Haase in his master work on that subject), occurs during the height of the fever, less often during the period of defervescence; swelling of the joint is at first slight and at this time the fever gradually increases. The inflammation may slowly subside and the joint completely recover. Again, the arthritis may persist, and pain and swelling gradually increase. The limb then assumes the vicious position — flexion, adduction and inward rotation — and if the hip is involved, favors the slipping of the femoral head out of the acetabulum. Luxation is usually observed during convalescence. Great relief from pain follows the luxation at the joint, because the tension of the muscles is overcome. The luxation is similar to that found in traumatic dislocations. The attitude of the limb is one of flexion, adduction and inward rotation, but unlike traumatic dislocation rupture of the capsule seldom or never occurs.

SPONTANEOUS DISLOCATION OF JOINTS

After typhoid fever, excepting tuberculosis, which is the most common cause of spontaneous dislocation of the hip, the next most frequent causes are polyarticular rheumatism and scarlatina. According to Ardisson there are three chief theories as to the cause of the dislocation:

1. Accumulation of fluid in the joint.
2. Proliferation of tissue in the joint.
3. The muscular theory.

Ardisson states that hydrarthrosis alone cannot cause a dislocation of the femur. It will pull the head up and away from the bottom of the acetabulum, and on a level with the rim, thereby preparing the way for the dislocation by distending and relaxing the ligaments. The joint is painful, and the muscles, therefore, place the limb in the most comfortable position; namely, that of flexion. The extensors soon become paretic and the antagonistic muscles, being unopposed, contract, causing adduction. The position of the femoral head on the posterior border of the acetabulum results in articular migration up and back with a true dislocation.

Verneuil believed that the tone of the periarticular muscles played a most important rôle in the causation of dislocation. In the early stage of the arthritis the muscles by involuntary contraction put the joint at rest to avoid pain. This muscular condition does not persist for any length of time, but modifies itself if the arthritis is prolonged. The extensors become paretic and the flexors contract, and finally are the only muscles acting. The localization of the paresis in the extensor group is almost constant. Pozzi explains this on the law of pathological anatomy that the degeneration selectively affects the muscles in proportion to their activity.

The salient features of dislocation connected with typhoid appear to be these: Dislocation usually occurs in the early days of convalescence when the patient is profoundly feeble. In many cases the precise instant of displacement is not noticed. In other cases some slight strain, as getting out of bed or turning in bed, is recognized as a contributing cause. In no case have joint phenomena been noticed before dislocation, and in many cases there is the positive statement that dislocation has been the first fact observed. The dislocation is attended and succeeded by very little pain. Reduction is usually very easy, even after some weeks, and recurrence has happened in several instances.

In rheumatism, on the contrary, the dislocation is preceded by marked evidence of acute inflammation attended by terrible suffering and a vicious attitude of exaggerated flexion and adduction. The occurrence of dislocation is almost immediately followed by great relief of pain.

Rawdon, in 1882, excised the head of the femur for dislocation following typhoid. It was perfectly normal; even the cartilage was healthy, save for a little absorption at the periphery. No synovial membrane could be found. The surrounding structures were especially healthy.

Adams, in 1884, performed the same type of operation for dislocation, the result of rheumatism. In this case the capsular ligament was ruptured and the torn margins passed on each side of and closely embraced the bone. The articular cartilage was normal.

Huebener, in 1897, reports the case of a girl, aged 14, with severe typhoid. On the thirty-first day there was a relapse of short duration. Two months later there was pain in the right hip, which was treated with salicylate of sodium. When the pain ceased, a dislocation of the joint was noticed. She was admitted to the hospital five months later with shortening of one and six-tenths inches. At operation the head of the femur was found loose at the epiphyseal line; the acetabulum was empty and surrounded by masses of granulation tissue. The head of the femur lay above and behind the acetabulum, embedded in the granulation tissue. The head of the bone and the new tissue were removed, and on examination were found to contain typhoid bacilli. Death occurred ten weeks later. There was no necropsy. This appears to us to have been a metastatic osteitis of the neck of the femur with necrosis and exfoliation of the head which is not at all a rare condition in metastatic pyogenic osteomyelitis of the cervix femoris.

Treatment. As spontaneous dislocation is secondary to a pre-existing arthritis, the importance of prevention at this stage is to be emphasized if the deformity is to be prevented. The attending physician should bear in mind the possibility of the occurrence of this complication and be on his guard when pain is complained of in the hip, and the limb assumes an abnormal position.

Extension by weight and pulley relieves the pain and assists in overcoming the faulty position, but is not in itself sufficient entirely to prevent luxation. The effusion plays so important a part in the production of luxation that aspiration is essential. Aspiration of the joint aids in preventing luxation and relieves pain. If luxation has occurred and effusion can be detected in the joint, the necessity for aspiration is great. The fluid should be aspirated and the joint should be injected with a few drams of a solution consisting of 1 per cent each of formalin, creosote, and guaiacol in 100 per cent glycerine.

The management of early luxations should be similar to that employed in congenital luxations. Bloodless reduction by the method of Lorenz, or a modification with the limb held in the Lorenz position by a plaster cast, will succeed in most cases, but the possibility of recurrence should be remembered. Reduction, however, should not be made until convalescence has been well established.

When in convalescence luxation has already occurred, reduction should be immediate and the limb should be maintained in position by extension and abduction, never by a plaster cast, as in the Lorenz method. The pathological findings in the cases that come to open operation show that the cartilage, both of the acetabulum and the head, is healthy in the majority of these cases, and therefore the immediate reduction can lead to a complete restoration of function in the joint. In other cases a separation of the head and epiphyseal lines occurs. Reduction in that class would prevent the abduction of the limb and favor the final result when an arthrotomy is done for the removal of the necrosed head. When the necrosed bone is removed the neck should be reinserted in the acetabulum and the limb dressed in a double abduction splint, bearing in mind that abduction of one limb cannot be secured accurately except with a body cast, but abduction of both limbs assures a continued reduction of the reposed head and insures a good result.

EXPERIMENTAL INFECTION OF JOINTS

Orloff found that the effusion in joints after injection of typhoid bacilli may be serous, seropurulent, or purulent; the first and second being more frequent. He injected 13 rabbits in the knee, at the same time injecting the opposite knee with sterile water or broth, according as he had employed an emulsion of agar growth or broth culture. One half to 1 ccm. was used, and the joints were studied after a lapse of from fifteen hours to thirty-seven days.

Twenty-four hours after the injection of typhoid bacilli, the joints were swollen and the subcutaneous tissues were œdematous.

In some instances the whole leg showed œdema, this probably being partly due to the 5 per cent phenol used for disinfection. Removal of the skin in the first twelve to twenty-four hours revealed dilated vessels, this being also true of the synovial membrane; at times there was actual hæmorrhage. In the cases investigated later, hæmorrhage was slight. In the joints, especially the upper recess, there was a thick, tough, more or less cloudy fluid, not infrequently in large quantities. Joints examined later contained opaque, white, moderately hard, kernel-like masses, and the fluid was more turbid and seropurulent in type. In from twenty-four to thirty-seven days the fluid was still more thick, and adherent to the synovial membrane. In the fluid of the first day, also later, were pus-cells in small or large numbers. Typhoid bacilli were present during the first two days, but after eight or nine days they were with one exception absent; in that one instance they were found on the thirteenth day. In the control knees the injected fluid was entirely absorbed.

Orloff also injected typhoid bacilli into muscles, and under the periosteum, etc., in order to investigate the pus-producing qualities of the organism. He later used sterilized cultures instead of living bacilli and obtained the same results, though the reaction was weaker. He concluded that suppurative foci developing during typhoid are due to that organism alone and not to mixed infection with pus cocci.

Arcoles injected broth cultures of typhoid bacilli into joints or veins of 5 young rabbits. He produced suppurative arthritis by direct injection into joints or by injuring joints after injecting bacilli into a vein. The effusion in the affected joints was found to contain typhoid bacilli.

Colzi injected typhoid bacilli into the vein of a rabbit's ear and then dislocated the hip. The animal died in forty-eight days, much emaciated, but otherwise without symptoms. The dislocated joint contained a large amount of pus, with a few typhoid bacilli. In a second rabbit he injected into a vein bacilli from the spleen of a child dead of typhoid, and immediately afterward fractured the femur. The animal died in ten days. The knee was found to contain a collection resembling pus with typhoid bacilli; at the point of fracture an abscess was found.

These experiments accentuate the stress which we have placed for the last third of a century on trauma as an essential factor in the focalization of the micro-organisms in joints.

Florange believes that typhoid arthritis comes often from a lesion of the neighboring bone. Most often, he believes, there is not a typhoid infection, properly so called, of the joint, but simply an irritation of the neighboring parts caused by an inflamed epiphysis; the articular effusion is sterile. (The sterility of the articular effusion is faulty in this hypothesis, as many of the metastatic arthritides have sterile effusions, for we have shown that the infection does not take place into the joint, but into the vascular layer of the synovial membrane.) In addition one rarely ever has an extension of an osteomyelitis infection into the neighboring joint, with the single exception of tuberculosis of the epiphysis. Osteomyelitis rarely ever occurs in the epiphysis. The epiphyseal lesion is here the principal lesion, the arthritis being secondary and less important. This view is corroborated partly by Klemm, who injected the ear vein in eight rabbits and later found a pure culture of the typhoid bacillus, though there was no arthritis. No pus was found in any of these cases.

Ellis injected typhoid bacilli directly into a joint in a series of 13 rabbits. In all of 12 animals which survived a sufficient length of time, a seropurulent or purulent exudate appeared in the joint. In three instances there was more or less extensive necrosis of the interarticular ligaments; in 1 there was erosion of the semilunar cartilages. In 3 cases there was destruction of the overlying soft parts and erosion of the articular surface of bone, in each the head of the tibia being affected. In 3 cases the muscles bordering the joint showed hyaline degeneration, accompanied or not by areas of necrosis. Inoculations were made from the joint contents in 11 of the 13 cases. The typhoid bacillus in pure culture was recovered in 5 after the lapse of one, four, eight, ten, and eleven days,

respectively. The exudate was sterile in 6 after six, eight, twelve, fourteen, fifteen, and sixteen days. Dead bacilli were used in two experiments; the source was of equal virulence. The results were entirely opposed to those of Orloff.

In general, according to Ellis, his experiments show clearly that the typhoid bacillus is capable of seriously damaging and even destroying the various elements entering into the formation of joints; the synovial membrane, interarticular ligaments, semilunar and articular cartilages, bone and joint capsule, and the surrounding tissues, including the muscle, were thus affected.

He believes that we are justified in considering all these destructive effects at least possible in human joints. There at once arises the objection that the bacilli experimentally were injected directly into the joints, while in man they enter the structures, directly or indirectly, via the blood. This, Ellis thinks, is not an insuperable objection. When the bacillus colonizes and multiplies in the joint, its effects must be much the same whatever the portal of entry; providing, of course, that preceding trauma does not play too large a rôle. While trauma is inflicted by injections, the puncture of the capsule by a fine needle is not a great injury. In none of the injections was there contamination by other bacteria.

Ten years ago Dr. Victor Schrager conducted for me some experiments of injecting joints with virulent pneumococci. He found that where the injection was made without traumatizing the articular surface with the needle no ill results came from the injection. While, in using from the same syringe-barrel the remaining half of its contents, and when the needle was inserted traumatizing the serosa of the joint with it, he succeeded in producing fatal phlegmons of the knee in the animals, showing what a great rôle the element of trauma, even of slight trauma — produced by the hypodermic syringe needle — plays in the destruction of the joint.

TREATMENT OF ARTHRITIS

When the knee is involved there is an early posterior subluxation of the head of the tibia, due to the contraction of the internal and external hamstring group of muscles. In the ankle the limb assumes a talipes equinus position very early in the disease. All of these luxations and changes of conformation are extremely dangerous to the subsequent utility of the limb. On account of the large surface in the joint and the close relationship of the capsule and pericapsular tissue, luxation readily and early occurs. *The prophylaxis of the luxation is of great importance, as permanent reduction after luxation is difficult of attainment.* How is this to be accomplished?

Joint destruction in typhoid arthritis is due to the same etiologic factors as in other types of acute virulent arthritides: namely, (*a*) the interarticular pressure produced by the products of infection, pus, etc., under tension hastens the destruction and absorption of tissue; (*b*) interarticular pressure, due to involuntary muscle contraction, favors destruction and absorption of the cartilage and bone ends when infection is present; (*c*) added to the above factors we have the biotic and toxic destructive effects of the invading micro-organism.

All of these should be relieved at their earliest moment of manifestation. Whenever a joint is involved, as for instance the hip or knee, a Buck's extension should be at once applied. It must be applied with greater care and watched more carefully for its pressure effects than one would need to do with other types of arthritis. Otherwise, dermatitis, pressure necrosis, etc., occur.

When the hip is involved the limbs should be dressed in double abduction, because then luxation cannot occur. The tension from the products of infection, when effusion or swelling in the joint are great, can be relieved best by (1) aspiration, which may be repeated frequently if tension recurs; (2) by injection and lavage of the joint with a 1:1000 or a 1:500 solution of the hypochlorite of calcium, with immediate suture of the soft parts. Drainage should never be inserted, as this would favor or rather insure subsequent synechiæ or ankylosis.

When the knee is involved great care should be taken to avoid hyperextension; that is,

a few degrees of flexion should be maintained and frequent changes of position resorted to. If the joint infection manifests itself after the acute symptoms of typhoid have subsided and the patient is in the convalescent stage of the disease, vaccines of the autosensitized type should be resorted to. In the knee and hip lesions a cast should never be applied, as that favors ankylosis. In the ankle the limb should be maintained in dorsal hyperflexion, which can best be accomplished by a cast. Passive motion, however, should be resorted to every day in order to avoid the tendency to ankylosis, which is always associated with a cast in these cases. When ankylosis has once developed, arthroplasty should be resorted to in about a year after the bony fixation has taken place. It never should be an early procedure, as latent viable foci of typhoid bacilli may be present. These produce an infection of the wound and militate against a good result. The simple opening of the hip or knee with lavage with the calcium hypochlorite solution or opening and lavage with the phenol solution with immediate closure not infrequently entirely cures the joint lesion in typhoid arthritis, as it does in the streptococcus arthritis of scarlatina, where this procedure early applied gives most splendid results.

I will be pardoned for calling attention here to the necessity of immediate and prompt action when a joint becomes involved by direct infection or after typhoid fever. Joints are saved by prompt action; they are lost by dilatory methods. There is no reason why a joint should not be opened and the pus let out any more than an abscess on a thigh, provided the joint is immediately closed and not drained. If the infection is virulent enough to produce periarticular destruction following the opening of the joint, it is virulent enough to produce interarticular destruction without opening and drainage. Therefore nothing is lost by this procedure and everything may be gained. In the treatment of all of these manifestations, the element of vaccines must be kept constantly in mind. True, much of this work is still empirical, but its progress is so great and its efficiency so positive, as seen by the results already obtained, that they should never be overlooked in the treatment of these cases.

PERSONAL CASE REPORTS

EXAMPLE 1. P. A., female, aged 18, was admitted to Mercy Hospital, August 25, 1911, because of trouble with her right knee following an attack of typhoid fever. Her family history is negative. She had had the ordinary diseases of childhood; whooping cough in September, 1907, for six weeks, and typhoid fever in October, 1908, for eight weeks. During the attack of typhoid, the patient says she was delirious most of the time and her temperature went up as high as 105° F., though there were intervals when she was conscious of persons and surroundings. December 12, 1908, the patient was convalescing from the fever and was standing at the side of the bed, supported by a nurse, when, on turning suddenly to get into bed, she heard a cracking sound in the right knee. The knee began to swell immediately, became red, and was so painful that she could not touch it, and the slightest jar of the bed would cause severe pain. Three days later, the whole thigh was swollen and remained so for a period of three months; the swelling occurred in ridges and would pit on pressure. The swelling of the knee continued after the thigh had become normal in size. When the knee first became inflamed the patient had no chill, but thinks she had a fever for a period of three weeks, rising toward evening every other day, but not very high. She was in bed until June, 1909. During all this time the knee was painful, tender to touch, swollen, and the patient did not try to bend it. In May she had been anæsthetized twice and the knee had been manipulated by six doctors, but they did not succeed in bending it. In the middle of June, 1909, the patient could walk a few steps on crutches, but the knee was still slightly painful and it could not be flexed or extended. At the onset of the trouble, the patient held the limb slightly flexed and it had become fixed in this position with inversion of the foot. In September, 1909, she could walk on the foot without crutches and the knee was not at all painful unless bumped or jarred. At present this knee will become tired quicker than its fellow when she walks long distances or stands for long periods of time.

Examination revealed a bony ankylosis of the knee with a very slight degree of flexion. There was no evidence of infiltration, œdema, or swelling in the neighborhood of the joint.

A typical arthroplasty was performed. On chiseling the bone free, in the center was found a small pocket of pus. This was thoroughly cleansed with 5 per cent solution, and the pus was turned over to the pathologist for culturing. It was felt that the field was absolutely sterile and the operation was completed in the usual way.

Microscopic examination and cultures showed the presence of the bacillus typhosus in the pus.

On the third day evidence of suppuration set in and the joint had to be opened and drained. The

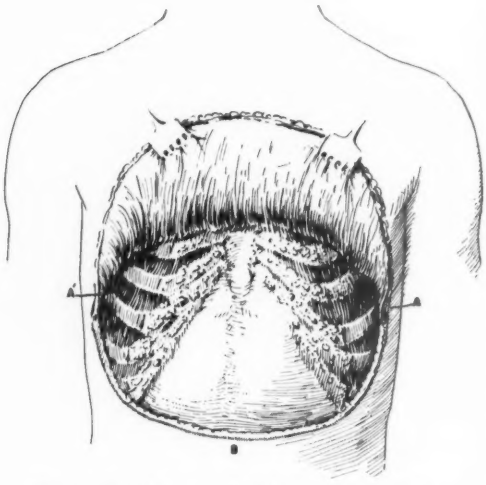

Fig. 7. Showing apron incision used in Example 3.

pus contained typhoid bacilli. Healing was slow, though repair was eventually complete, but it left the patient with only a very little degree of motion. The flaps did not slough or necrotize.

Since this time we have made it a rule whenever we find a pus pocket in the process of operation for arthritic lesions, to clean it out, close it up and permit a bony union to occur, so that later the operation may be performed in an absolutely sterile field.

TYPHOID SPINE

EXAMPLE 2. L. L., male, aged 16, entered Mercy Hospital, October 15, 1914, with the following history:

He had had the usual diseases of childhood. From April to May, 1913, he had a mild attack of malaria. In May, 1914, he had typhoid fever, which lasted nine weeks. For the first seven weeks he was in bed and for the remaining two weeks he could sit up. For the next two weeks he was able to walk around town. On September 8, 1914, while lying down he had an acute pain in the lumbar region, shooting and sharp in character and traveling around on to the upper abdomen. The abdomen was distended and the muscles seemed to twitch. The patient felt feverish, but had no chills and no nausea or vomiting. This attack lasted a half hour, disappeared, and returned again in about six hours, both attacks occurring about two hours after meals. Following that, the patient had three or four similar attacks a day until September 25, 1914. He had night sweats and ran a temperature from 99° to 103° in the evening. The urine showed some albumin, but cleared up shortly. The bowels were constipated, and the stools black and tarry. There was marked tenderness to pressure over the lower dorsal and lower lumbar vertebræ, and slight curvature of the spine. The patient was put in a plaster cast, extending from the arms down to the hips. The cast was left on for two weeks, with the patient in bed. The pains decreased, the temperature dropped to normal, and the patient was then put on a canvas splint. His condition showed no marked improvement.

Examination. He has no paralysis. The pain from which he complained in the beginning was a sharp acute pain, not a colicky pain, and it extended over the upper abdomen. Anteroposterior and lateral motion in the spine increased this pain. When the patient was admitted to the hospital, his Widal reaction was found to be positive and, what was of greater importance, the bacillus typhosus was isolated from his blood, fæces, and urine, showing that he was a typhoid carrier and that he was suffering from a typhoid spondylitis. This does not mean a caries of the spine. It means an osteo-arthritis of the spine, involving also the peri-articular tissues. The œdema and swelling cause pressure on the spinal nerve, which is reflected forward over the chest, abdomen or thigh or the areas supplied from their respective nerve-roots.

The gall-bladder was opened and its contents aspirated into a syringe and cultures made. They teemed with typhoid bacilli. The appendix was removed and was filled with fæces containing typhoid bacilli. Gall-bladder was drained.

After the operation the typhoid bacilli entirely disappeared from the blood. They were found in the urine on the second examination, but were absent from both urine, bile, and fæces three weeks later.

This is a striking example of the late osteo-arthritides of typhoid. It is not our interpretation of this case that the typhoid bacilli were deposited in the spine during the fever, but that they were deposited from the blood after the patient got about and was exercising, whereby he produced a point of lesser resistance in which the bacilli were deposited and multiplied. No operation was performed on the spine. He was put in a straight-jacket, typhoid vaccines were administered, and the case went on to recovery, with some fixation of the spine, which we believe will be absorbed.

How long the bacilli remain in the blood in the typhoid carriers has not been definitely determined. Therefore a patient carrying the bacilli, if he is about, is much more liable to the osteo-arthritic lesions than he is while confined to bed.

TYPHOID CHEST-BONE

EXAMPLE 3. J. A., male, was admitted to Mercy Hospital, April 13, 1901. Four years previously he had suffered from an acute attack of typhoid fever, lasting for eleven weeks. Following this he had

pain in his chest-bone and two months later he developed sinuses just anterior to the sternum. These had been opened and drained innumerable times before he came to us.

Examination revealed sinuses extending in various directions along the surface of the sternum and out along the costal cartilages. These were opened and drained. Finally a definite plan of procedure was outlined.

The apron incision was used (see Fig. 7).

A curved incision was made from the costochondral junction of the rib most involved, downward over the abdomen, clear up and across to the opposite side, from point A down to B and then up to A′. The flap is then dissected, elevating all of the tissues, including the attachments of the recti, and turned up so as fully to expose the diseased cartilages. Each one was removed for its entire extent, from the sternum to and including the osteochondral junction. Most of the granulation tissue was beneath the costal cartilages. The costal margin was also removed clear around for the full length of the incision, until a perfectly normal cartilage was found. The field was then thoroughly cleansed and complete repair went on.

This man had had a number of minor operations which had had no effect, but this radical procedure, which is the type of procedure we feel should be used in this class of cases, proved most satisfactory and resulted in complete cure.

EXAMPLE 4. H. S., male, aged 33, was admitted to Mercy Hospital, February 15, 1916, because of a discharging sinus in his thorax. His family and past histories are negative, and he denies venereal infection.

April 1, 1914, while having some dental work done, the dentist's drill fell, penetrating his chest on the right side over about the fifth rib and three inches to the right of the sternum. It was immediately removed. April 4, 1914, the wound became painful and swollen and he had some temperature. April 9, 1914, an abscess was opened and a great deal of pus escaped. A small rubber drain was inserted and he remained in bed for about two weeks. His temperature at this time was normal and he had no chills. The wound drained until July, 1914, when he was given an anæsthetic at home and the seventh rib on the right side about the junction of the cartilage and bone was rongeured out. He did not have any chills or temperature, but remained in bed for one week. The wound continued to drain until December 8, 1914, when he went to a hospital. Drainage at this time was very profuse and the wound was swollen and painful. Hot dressings were applied for one week and then an operation performed. The wound drained from the time of the operation on December 18, 1914, to July, 1915, when a mass of flesh about the size of a hen's egg appeared above the ensiform and one-half an inch to the left. He had no chills or temperature. His doctor opened this mass and it drained until November, 1915, when another operation was performed on the lower part of the sternum. He remained in the hospital three weeks. He had no chills or temperature. From this time on the wound has continued to drain from the lower and left part of the sternum. At present there is marked pain at the eighth rib on the left side, extending directly back for a distance of five inches.

Examination. Admitted to Mercy hospital February 8, 1916. This case is one of mycelial infection from the mouth, which resembles a tuberculosis in its manner of causing destruction of the tissues. He is very sore over the perichondrium and left rib, and the soreness extends to the left side. A tuberculin test proved negative. A culture made from some of the discharge showed no tubercle bacilli.

This infection came from the mouth, which is unusual. Such infections are hæmatogenous. I have never before seen a case in which the infection came from the mouth. The infection appears to go in beneath the costal cartilage and to be on the inner side of the tip of the sternum and ribs. The only incision that is of any value in such cases is the vest incision, which is made as though one were going to open his vest.

An incision was made, beginning at the lower angle of the sternum and extending around to the right, through which the costal cartilages were well exposed. A sequestrum of cartilage was found in a granulated tissue mass. This cartilage was freed and removed entirely. The granulation tissue extended beneath the cartilages entirely to the bony ends of the ribs. All of the diseased cartilages were removed in the same way. All the granulation tissue was curetted from underneath the cartilages after they had been removed. Drainage tubes were placed at the upper and lower angles and were removed after four days. The large skin flap was drawn back into position and sutured with silkworm-gut and horsehair.

In this case the seventh and eighth cartilages were involved, extending from the sternum outward toward the rib; they were both removed for their entire length. The sternum itself was not involved, but the granulation tissue went under the cartilage.

March 6, 1916, the patient was still in the hospital, progressing favorably.

PRIMARY TREATMENT OF WOUNDS IN CIVIL PRACTICE [1]

By MILES F. PORTER, M.D., F.A.C.S., Ft. Wayne, Indiana

IT is proper for me to say that for twenty-five years I had a large experience in the treatment of accidental wounds, chiefly railroad and shop injuries. The shop wounds were for the most part those received in wood or metal working concerns. The most important lesson taught me by this experience is twofold; viz., first, a greater respect for the inherent resisting power of the tissues to infection, and second, less confidence in my ability to cleanse infected wounds.

Measured from the standpoint of the patient, this is the most important surgical lesson I ever did learn.

Belief in the old dictum that "Nature is a good physician but a poor surgeon" has done more harm than good. The fact is that she does fairly well in both branches of practice provided she receives intelligent aid rather than pernicious interference. The primary dressing should be the final one in many cases, and in the vast majority of cases it should not be changed until granulation is well established. To change the dressing on a wound unnecessarily is a surgical sin.

I would not be understood as minimizing the necessity for surgical cleanliness, but I would warn against the danger, which my experience has taught me is very real, of doing more harm than good by too vigorous use of mechanical and chemical means in efforts to secure a clean wound. Generally speaking, one should refrain from using strong antiseptic lotions and from vigorous attempts at the mechanical cleansing of wounds. Except in rare instances wherein infection is especially imminent, as in dog bites, wounds made by objects infected with horse manure, etc., the use of strong germicidal agents should be decried.

For years I have advised against the use of antiseptic solutions of even the ordinary strength — say 1:1000 bichloride of mercury — in the cleansing of recent lacerated wounds, on the ground that the antiseptic killed or injured the surface cells and failed to penetrate the deeper parts of the wound. Weaker solutions are advised because they are less harmful to the cells and penetrate more deeply.

I have not tested the matter in my own work, but, from the results recently reported by others and from my own experience in the treatment of infected wounds, I have a feeling that antiseptic solutions will in the near future give way to sterile normal salt solutions for the cleansing of accidental wounds.

The "thorough use of the curette" for the removal of foreign particles and rough and prolonged search for foreign bodies is unsurgical and unwarranted. The surface of a wound is best cleansed of foreign particles by a stream of sterile water or mild antiseptic solution and the use of dry gauze wipes, supplemented when necessary by the use of forceps.

In my own work in cleansing wounds and the areas immediately surrounding them, gauze has largely replaced the brush and curette; time, patience and care have supplanted vigor; and strength in antiseptic solutions has been abandoned in favor of quantity.

Where there is strong reason for believing that foreign bodies are imbedded and are likely to cause trouble it will be better to allow them to remain at the primary dressing and wait until Nature has had a chance to complete her defenses before attempting their removal.

Hæmorrhage and shock are conditions not infrequently making the most urgent demand for relief. They are spoken of together because I have never seen shock without hæmorrhage except in injuries to the abdomen or brain. The following hypothetical case will illustrate my position as to the treatment of shock and hæmorrhage.

A patient with a knee and leg crushed beyond hope of repair is seen shortly after receipt of the injury suffering severely from shock and hæmorrhage. A tourniquet is

[1] Read at the meeting of the American Surgical Association, Washington, May 9, 10, 11, 1916.

applied, a hypodermic injection of morphine and atropin is given, artificial heat applied, a transfusion is done, hypodermoclysis or rectal injection is given if necessary while the patient is being anæsthetized, or if the need for this stimulation is not urgent the amputation is quickly done and a sufficient amount of normal salt solution is injected into the open mouth of a vein in the stump after removal of the tourniquet, and the wound is now closed and dressed. This patient will go off the table in much better condition than he was in when he went on the table, will awaken relatively comfortable and without the fear and dread of a prospective operation.

A large number of cases similar to the above has fully convinced me that to postpone amputation until the symptoms of shock have subsided is a grave mistake.

Cases involving amputation of the thigh, double amputations, and one quadruple amputation have done well treated on this plan, and while not all patients have recovered, none have died of shock.

It would be presumptuous to say to this audience that no amputation should be done except in cases where all hope of saving a better member than the instrument maker can make is lost, and yet a large experience involving, for a period of years, daily contact with wounds produced by powerful and heavy machinery constrains me to say that primary amputations in general should be of rarer occurrence than they are at present, and that primary amputation of a finger is seldom wise.

In like cases all surgeons would probably be governed in their treatment by the same principles, but some would have more faith in the recuperative power of the tissues than others, and therefore more "hope." My plea is for more of this hope-breeding faith.

There is great danger of doing too much at the primary dressing in badly contused and lacerated wounds in other directions also than those looking to surgical cleanliness, and especially is this true in wounds of this kind complicated by fractures. The temptation is great to readjust structures as nearly to the normal as possible and fix them with sutures, wires, nails, plates, etc. That this, our zealousness, has caused the loss of limbs and lives that might have been saved by a less strenuous but more judicious primary dressing is beyond question. Moreover, undue efforts at coaptation and fixation at the primary dressing not infrequently make necessary subsequent osteoplastic, tenoplastic, and other repair operations that might be entirely avoided or rendered much less extensive by withholding these efforts. Sutures at the best are a necessary evil, and in contused and lacerated wounds peculiarly evil and seldom necessary. Of course it is understood that nothing in the foregoing is to be taken as weighing against the immediate suture of tendons, nerves, muscles, etc., in cases (incised wounds for instance) where the indications for these procedures are clear, but as urging the danger of sutures in contused tissues, the advisability of dispensing with them very largely in the skin in favor of adhesive plaster and properly applied dressings, and protesting against the use of nails, plates, wire, etc., for purposes of bone fixation and coaptation in the primary dressing of wounds complicated with fracture.

One should be extremely cautious about removing bits of tissue which seem hurt beyond recovery, and this caution should be emphasized in dealing with wounds of the hands and fingers. The objection to this "trimming" process is that it opens new atria for infection, causes unnecessary sacrifice of tissue, increases the bleeding, and adds to the time of anæsthesia. The surgeon will do this "trimming" job more expeditiously than Nature, but Nature will do it much more economically and safely.

As a rule dry dressings are preferred. Raw surfaces should be covered by narrow strips of protective to prevent sticking of the dressing and the consequent disturbance of the granulations when the dressing is changed. A non-odorous, non-irritating antiseptic powder used freely in lacerated wounds is advantageous.

The dressing should be applied with a view to securing as perfect local rest to the parts as possible in a position conducive to comfort and healing. Should the primary dress-

ing become stained with serum or blood, the spot should be covered with powdered boric acid and an additional dressing applied.

The question of tetanus naturally and properly always arises in the mind of the surgeon when he is called to treat an accidental wound.

Having never seen a case of tetanus arising from a shop or railroad injury, although I had treated thousands of such injuries, and having seen a number of cases of tetanus following injuries received in barn-lots and on the streets, although I had treated relatively few injuries of this kind, the conclusion was naturally reached that prophylactic measures against tetanus were uncalled for and would better be withheld in the treatment of all accidental wounds save those received under circumstances rendering infection by the tetanus bacillus probable.

Before venturing to voice this opinion, however, it was considered wise to get the opinions of other Fellows of large experience in accidental work. Five letters were written and replies received from all. One surgeon seemed to miss the main point of my letter and his answer is, therefore, not germane. Abstracts of the remaining four are as follows:

I have been Division Surgeon at this point for the Northwestern lines here in Omaha for about 25 years. I have also been Chief Surgeon for the Union Pacific Railroad since March 1, 1898, and, in all that time, I do not recollect having seen a single case of tetanus arising from injury to railroad men while engaged in their regular occupation, neither have there been any reports of cases of tetanus from any point on the lines above-mentioned coming to my office. Therefore I would say that the etiological factor of tetanus does not exist in the railroad service proper. (A. F. Jonas)

Replying to your letter of the 26th inst., I would state that I have been Surgeon to the Pennsylvania lines west in this district (Pittsburgh) since 1882 and was actively engaged in attending the injured men in the railroad shops in Allegheny City for the first twenty years of that period. I have no recollection of having had a single case of tetanus following an accident in these shops. We had one case in the early 80's, but my recollection is that it was not a shop case. Tetanus in my experience has nearly always occurred in patients who were injured on the street, in yards, in stables, or by the use of percussion caps.

I have inquired of Dr. D. C. Boyce, who has been doing the shop work for the last ten years, and he has never had a case of tetanus among these men.

I am speaking, however, from memory and not from records, but this is a subject in which my memory cannot be at fault. (J. J. Buchanan)

My experience with wounds and injuries in railroad shops and in factories has shown almost entire absence of tetanus. I cannot recall a single case of tetanus arising within factories or railroad shops unless the individual had something to do with horses, say covered by a horse blanket in being brought to the hospital. It is another matter when a man is injured on a railroad crossing, however, that is where the highway goes across the railroad. (W. L. Estes)

I do not now remember having seen a case of tetanus arising in connection with an injury received on a steam railroad or in a factory. I have seen a few cases of tetanus in connection with street-car injuries occurring in the streets of Chicago. In the coal mines of Illinois that have been under my care since 1912, since which time they have been under the Compensation Act, although we have had thousands of injuries, there has not been a single case of tetanus reported. (M. L. Harris)

In view of the foregoing facts and taking into consideration the danger of anaphylaxis and the undesirability of sensitizing a patient, we may conclude that prophylactic injections of antitetanic serum should not be used save in patients with wounds inflicted under circumstances rendering infection by the tetanus bacillus probable.

SEPARATION OF THE LOWER FEMORAL EPIPHYSIS

With Report of Two Cases

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SEPARATION of the lower femoral epiphysis is of rare occurrence. Radical treatment of the condition is so necessary that the following cases are reported for the interest they may add to the present literature on the subject.

This type of fracture usually occurs from direct violence, such as the catching of a leg in the spokes of a revolving wheel. The deformity is usually a displacement of the epiphysis backward into the popliteal space, the lower end of the shaft projecting its sharp edge forward above the patella. Conservative treatment of such displacement by the inclined plane, or other traction and splinting methods are useless. Closed reduction under an anæsthetic is accompanied by dangers, injury to the popliteal nerves and vessels, and the improbability of obtaining complete reduction. In a joint which is as important as the knee-joint a slight deformity may result in permanent injury to the epiphysis followed in due time by irregular growth and increasing deformity. Also blood in the joint filling the quadriceps pouch as well, if allowed to organize with the knee kept at rest will spell disaster to the return of joint motion. The importance of removal of blood-clot from the knee-joint cannot be overestimated, for many stiff knees, not the result of sepsis, are the direct result of the obliteration of the joint in the process of the organization of blood-clot. Hence the use of a tourniquet in all knee-joint surgery is, in the opinion of the writer, very necessary.

The open reduction of this deformity not only is simple, but should always succeed in giving proper alignment and a clean, blood-free joint. Hence it is always best to resort to operation in this and in similar injuries. The risk of operation should be minimized of course by the strictest attention to the details of asepsis and by hæmostasis; both should be as perfect as may be obtained. It may seem superfluous to emphasize such detail, but it is only by extreme care that the many pitfalls attending joint surgery may be avoided, and only by such care that good as well as constant results may be achieved.

The details of operative procedure are as follows: A tourniquet is applied. A lateral incision, usually on the inner side, is carried down to the seat of fracture by blunt dissection, and the accumulated blood-clot thoroughly washed out. With a blunt dissector or other heavy instrument, the lower fragment is pried into place, usually without much resistance and usually with complete anatomical reduction of fragments. The well-fitted serrations give to the reduction a valued stability and as well, insure the slightest possible injury to the epiphysis. The soft parts are closed with catgut and the skin with silkworm-gut. A tight bandage is applied over the dressing and the tourniquet is removed. Plaster is then applied from the groin to the ankle. At the end of one week, the plaster is split and a few degrees of motion made without removal of the leg from posterior shell. This process is repeated gently each day. The plaster is taken off after ten days, and from this time on there may be expected an uneventful convalescence. Note especially Case 1 and the photographs of the end-result. Case 1 was operated on 18 hours after the accident. Case 2 was not operated on for three weeks, which accounts for the knee allowing only 100 degrees motion in flexion.

Case 1. George M., age 9; referred by Dr. Francis McMurray of Fitchburg. The patient was a healthy boy with the exception of enlarged tonsils and adenoids for which he was operated upon April 10, 1912. On Friday, May 17, 1912, while stealing a ride on the back of a baker's wagon, his right leg was caught in the spokes of the rear wheel. His screams attracted the attention of a passerby who called to the driver, and the cart was brought to a stop. The boy complained of

TABLE OF CASES

No.	Author	Age	Cause	Type of Injury	Treatment	Result	Reference
1	Bauer	7	Blow on knee	Epiphysis of left knee displaced backward and outward	Resection of knee	Recovery with good function	Cited by Monsehr. Inaugural Dissertation, Greifswald, 1807, 20; cited by Hilgenreiner, loc. cit., p. 180.
2	Binney and Lund	11	Leg caught in spokes of wheel	Displacement of epiphysis outward and backward	Ether plaster	Good immediate result	Boston City Hosp. M. & S. Rep., 1913.
3	Binney and Lund	10	Fall	Slight posterior displacement of epiphysis	Plaster	Good immediate result	Ibid.
4	Roughton	5	Leg caught in spokes of wheel	Compound separation of epiphysis with rotation backward	Resection of femur	One-half inch shortening and slight flexion; partial ankylosis	Lancet, Lond., 1900, i, 233.
5	Cottam	6¾	Caught in spokes of wheel	Compound fracture. Diaphysis displaced outward, epiphysis backward	Resection and wiring	Boy became knock-kneed	Med. Rec., N. Y., 1905, lxvii, 487.
6	Cotton				Manipulation		Dislocation and Joint Fractures, 1911, p. 505.
7	Cotton				Manipulation		Ibid.
8	Coural	11	Fall forward with knee in hole	Diaphysis dislocated into popliteal space. Epiphysis tilted backward	Secondary amputation	Recovery	Cited by Delpech. Chir. Clin., 1823, i, 252; cited by Poland, loc. cit., 732.
9	Dukes	18	Struck on outer side of knee	Epiphysis slightly rotated backward	Pressure pad over epiphysis	Union in 6 weeks without shortening	Brit. M. J., 1874, p. 402.
10	Fenwick		Fall	Epiphysis displaced backward and drawn up in front of the diaphysis			Proc. Roy. Soc. Med., Lond., 1911, v, Electro-Therap. Sect., p. 156.
11	Fischer and Hirschfeld	17	Caught in belt	Diaphysis slightly displaced forward. Epiphysis rotated so that the internal condyle ascended somewhat forward and the external condyle descended backward		Fracture consolidated with some displacement and rotation of the epiphysis	Berl. klin. Wchnschr., 1865, ii, 93.
12	Haldermann	18	Blow on front and inner side of thigh	Epiphysis tilted backward and overlapped by the shaft on its posterior and outer aspect	Double inclined plane. Secondary amputation	Death from pyæmia	Med. Rec., N. Y., 1882, xxi, 600.
13	Hartwell	16	Fall from horse	Oblique fracture with lower fragment displaced backward	Osteotomy	Healed in 12 days	Ann. Surg., Phila., 1904, xl, 1022.
14	Hilgenreiner	7½	Forcible reduction of congenital hip	Epiphysis displaced backward	Plaster	Union in 3 weeks	Beitr. z. klin. Chir., Tubing., 1909, lxiii, 102.
15	Hilton	18	Fall with weight on shoulder	Epiphysis displaced backward, diaphysis forward	Reduction	Firm union in 7 weeks with good function	Med. Times & Gaz., 1859, 163; cited by Poland, loc. cit., 765.
16	Hutchinson	12	Run over	Compound fracture	Primary amputation		Tr. Path. Soc., 1864, xv, 206.
17	Hutchinson	14		Epiphysis dislocated backward	Primary amputation		Arch. Surg., 1893, iv, 4, 287.
18	Jouon	7	Leg caught in spokes of wheel	Compound fracture. Epiphysis rotated and pulled backward	Primary amputation	Recovery	Rev. d'orth., Par., 1902, iii, 488.

19	Laugier		Fell into hole	Epiphysis displaced backward and drawn up in front of shaft	Secondary amputation	Death	Nouveau dictionaire de médecine et de chirurgie practiques. Paris; 1869. Cuisse, p. 498; cited by Poland, loc. cit., 732.
20	Macdougall	20	Leg caught in endless rope	Very great backward displacement	Splint. Secondary amputation	Recovery	Edinb. M. J., 1890, xxxvi, 825.
21	McDiamid	8	Leg caught in wheel	Epiphysis rotated so that the articular surface looked forward and the detached surface backward	Primary amputation	Recovery	Northern Lancet, Winnepeg, 1891, v, 1.
22	Packard	9	Leg caught in wheel	Compound fracture with shaft protruding backward and epiphysis rotated backward	Primary amputation	Recovery	Med. News, 1891, Mar. 21, 339; cited by Poland, loc. cit., 729.
23	Poland (A)	13	Fell down step	Epiphysis displaced inward and a little backward. Shaft displaced outward	Extension	Union in 7 weeks	Poland, loc. cit., 774.
24	Poland (J)	3½	Fell on hands and knees	Epiphysis displaced backward and inward	Reduction under ether. Plaster	Union slowly with considerable thickening	Poland. Traumatic Separation of the Epiphysis. London: 1898, p. 685.
25	Prochnow	10	Fell on knee	Epiphysis displaced backward and outward	Double inclined plane	Necrosis of skin. Recovery in 8 months	Gyógyászat. Budapest, 1892, Nov., xxxiv, 545; Abstracted Pest. med. chir. Presse, Budapest, 1893, xxix, 389; cited by Poland, loc. cit., 741.
26	Reboul	7	Leg caught in spokes of wheel	Epiphysis rotated so that its fractured face looked backward. Diaphysis displayed into popliteal space	Extension. Open reduction. Metallic sutures	Slight genu valgum. No shortening. Movement normal. Function perfect	Ass. franc de chir. Proc., verb. (etc.) Par., 1904, xvii, 617.
27	Reboul	17	Fell from horse	Diaphysis displaced outward and backward. Epiphysis rotated upward and backward	Open reduction. Metallic sutures. Secondary amputation	Recovery	Ibid.
28	Richet	13	Leg caught in strap of machinery	Compound fracture. Diaphysis projected on outside. Secondary displacement of epiphysis backward	Reduction without anæsthetic	Death	L'Union méd., Par., 1876, xxi, 426.
29	Roberts			Displacement of epiphysis into popliteal space	Conservative	Recovery with good function	Ann. Surg., St. Louis, 1896, xxiii, 201.
30	Schmidt	6½	Struck with hammer	Epiphysis displaced backward	Reduction under narcosis	Recovery with good function	Fortschr. a. d. Geb. der Roentgenstrahlen, 1899, iii, 1.
31	Sheppard	15	Leg caught in spokes of wheel	Epiphysis dislocated backward and outward. Diaphysis displaced inward	Immobilized in slight flexion, later extension.	Union in 7 weeks with good function	St. Thomas's Hosp. Rep., 1877, viii, 433; cited by Poland, loc. cit., 767
32	Sheppard	15	Fall	Shaft projected forward	Splint with leg flexed		St. Thomas's Hosp. Rep., 1877, viii 436; cited by Poland, loc. cit., 766.
33	Specimen at St. Georges Hospital No. 56 A	18	Leg caught in cable	Epiphysis displaced backward and outward. Diaphysis displaced inward	Amputation	Death	St. George's Hosp. Mus. Cat., 1866, p. 43; cited by Poland, loc. cit, 721.
34	Sturrock	11	Run over by cab	Epiphysis displaced backward and outward	Flexion	Slight thickening. Perfect function	Edinb. Hosp. Rep., 1894, ii, 598.
35	White			Compound fracture with end of shaft protruding forward	Resection	Recovery	Cited by Poland, loc. cit., p. 719.
36	Evans			Separation of lower epiphysis of right femur backward			J. Royal Army Corps, Lond., 1914, xxiii, 348 (Article not seen).

much pain in the region of the right knee. There was much swelling and evident deformity at the knee. The radiogram showed an epiphyseal separation with the displacement backward, inward, and slightly upward so that it came to lie against the posterior aspect of the shaft (Fig. 1).

Operation, May 18, 1912, under ether anæsthesia. An incision about three inches long was made on the inner side over the epiphyseal line down to the fracture. The blood-clot was washed out with salt solution, and by the use of a blunt dissector the fractured epiphysis was pried into place so that the serrated edges fitted perfectly and there was no deformity at any point. The wound was sewed up in the usual manner, and dry dressing and plaster from the ankle to the groin applied with the knee at 180° (Fig. 2). On May 27, the stitches were removed. The wound healed by first intention. On June 3, the patient sat up in a chair. On June 11, he was discharged from the hospital. The plaster was removed entirely at the end of two weeks. His highest temperature was 100.8°. Convalescence was uneventful; motion was regained rapidly. The end-result is perfect (Figs. 3 and 4).

Case 2. A. C., age 17; referred by Dr. S. M. Gordon, Fall River. The patient had an injury in one of the Fall River mills, March 6, 1911, in which he sustained a compound fracture of the left leg, crushing the ankle-joint. Both bones were fractured low in the tibia through the tibial condyle. The right foot was contused and lacerated. The right lower femoral epiphysis was displaced backward. On April 10, 1911, the left foot was amputated by Dr. Gordon. On May 13, 1911, the patient was seen in consultation with Dr. Gordon and open operation advised for the reduction of the displaced epiphysis (Fig. 7). The epiphysis was separated and dislocated backward into the popliteal space. The shaft projected forward.

Operation, May 13, 1911, under ether anæsthesia. An incision was made on the inner side of the knee at the point of fracture and the epiphysis pried in place by means of a blunt dissector. A cast was applied. Recovery was uneventful. On June 2, the cast was removed. On October 16, he was discharged from the hospital, wearing a caliper brace. On March 8, 1912, he was admitted to the hospital for correction of slight knock-knee, and a supracondylar osteotomy was done. On April 13, there was good union from the osteotomy and alignment was good. On May 4 the patient was up and about, walking with brace.

Bauer's case was that of a 14 year old boy who had developed a deformity from an unrecognized separation of the epiphysis seven years before. There was present genu valgum and marked shortening.

Binney and Lund advise in the average case of epiphyseal separation open reduction with a nail through the condyle, although they had used this treatment in only one of the cases given in their report. In the two cases cited, one of backward displacement, the other of backward and outward displacement, reduction by manipulation was found sufficient.

Cotton advises reduction by traction on the leg, with the knees bent with direct pressure on the protruding fragment.

Coural's case was related by Fontelli, and the specimen which was in his possession described by Delpech. The child was without treatment for four days. At the end of that time routine treatment failed to reduce the deformity, and amputation was refused although gangrene had developed. Twenty-three days later the foot separated from the leg, and finally Coural amputated four inches above the condyles. The epiphysis was found separated from the shaft in the middle of the cartilaginous layer.

Dukes reported a case of a boy who received a blow on the outer side of the right leg while his legs were abducted in full extension. The epiphyses was felt as a prominence in the median line. Suspension with pulleys was unsuccessful. A straight "long outside" splint with perineal extenders was better. Finally a pressure pad was added, the perineal band removed and extension employed.

In the case reported by Fischer and Hirschfeld, the boy was caught in the belt of a threshing machine, resulting in the separation of the lower epiphysis of the right femur, the upper epiphysis of the left tibia and both epiphyses of the left fibula. Amputation through the upper part of the left thigh was later necessary. The right leg was first put on a double inclined plane and icebags applied. In a few days, the part was put up in plaster. Recovery was slow.

Halderman's case was of a mulatto with tuberculosis. Conservative treatment was undertaken although the dorsalis pedis was pulseless. Replacement under narcosis was attempted. Gangrene set in, requiring secondary amputation. On dissection considerable destruction of the soft parts was found and the nerve caught between the fractured ends of the bone. The patient recovered from the operation but died thirty days later from pyæmia.

Fig. 1. Radiogram of Case 1 before operation.

Fig. 2. Radiogram of Case 1 after operation.

Fig. 3. Radiogram one month after operation, showing end-result.

Hartwell reported one case in which the line of fracture was oblique from a point about 2 inches above the epiphysis on the inner side of the femur, outward and downward to the epiphyseal line at the center of the bone. An osteotomy was performed through the line of fracture and the fragments were brought into apposition by traction and manipulation with bone hooks. The wound was closed with drainage and the leg put up in plaster.

Hilton reports a case of a boy of 18 who fell while carrying a hod of coal. The deformity was reduced three times under narcosis; the first time by extension, the other times by extension and pressure on the shaft. After the first recurrence, a posterior splint was applied. After the second, posterior and lateral splints, and the leg was elevated with the thigh flexed. Firm union resulted in seven weeks.

In Jouon's case, the leg was severely twisted and almost torn off above the knee. The knee-joint was opened behind and the nerve and bloodvessels torn. The diaphysis protruded 5 cm.

Macdougall reports a case seen by him for the first time a month after the injury. The surgeon who had attended the boy at the time of the trauma was unable to reduce the lower fragment which was drawn very acutely backward so that the integument was drawn taut. There was not much displacement of the shaft. The limb was put up finally in a splint and fixed at a not very acute angle. When Macdougall saw the child, the limb was shrunken and the skin over the dislocated fragment ulcerated and there was no attempt at union. After amputation, the vessels were found uninjured.

In Packard's case, examination under ether showed that although there had been great bruising and laceration of the soft parts, the vessels were not torn but were sharply stretched and the blood in the artery coagulated. Reduction was found impossible without resection and as this was thought inadvisable amputation was performed.

In simple cases Poland advised reduction under anæsthetics, by manipulation where this is possible. Where there is danger of injury to the soft parts, or where muscle or periosteum have become interposed between the

Fig. 4. Photographs showing extension and flexion after union in Case 1.

Fig. 5. Photograph of Case 2 after union.

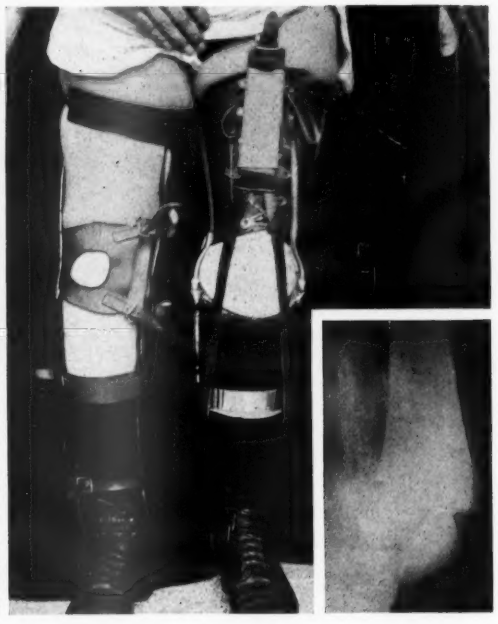

Fig. 6. Fig. 7.

Fig. 6. Photograph showing brace in Case 2.
Fig. 7. Radiogram of Case 2 before operation.

fractured ends, or when a correct position cannot be maintained, he advocated open operation and suturing of the fragments. It may sometimes be necessary to remove a portion of the diaphyseal end. He puts the limb up on a double inclined plane. Amputation, he believes, is preferable to excision of the epiphysis, but should be performed only after the gravest injury to the soft parts, for gangrene, suppuration, or severe after-results.

Prochnow gives a case caused by falling on a curbstone, striking the knee violently. The knee was displaced backward and outward. The patella was drawn toward the outside. The limb was put up in partial flexion on a double inclined plane, which did not entirely overcome the deformity, causing necrosis later of the skin, exposing the bone for 1 to 2 cm. The exposed bone necrosed with a moderate amount of suppuration.

In Richet's case, the leg was caught in a strap of machinery and twisted violently so that it was bent upon the thigh to a right angle. The end of the diaphysis, covered with epiphyseal cartilage projected through a large wound on the outer aspect of the thigh. The joint was intact and the femoral condyles and the patella remained in normal relations to the tibia. Reduction without an anæsthetic was followed by delirium, elevation of temperature, etc. Death from pyæmia occurred on the sixteenth day. During the convulsions, the epiphysis was displaced backward.

Robert's case was complicated by injury to the external popliteal nerve, resulting in toe-drop. This condition ultimately disappeared without operation.

In the case of the specimen at St. George's Hospital Museum, there were injuries to soft parts and separation of the epiphysis of the tibia and fibula. Amputation was done. Death from pyæmia resulted in 14 days.

THE INDICATIONS FOR AND RESULTS OF CEREBRAL AND CEREBELLAR DECOMPRESSION IN ACUTE AND CHRONIC BRAIN DISEASE

With Remarks on Decompressive Craniotomy for Intracranial Injuries[1]

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IN order to have a proper idea of what a decompressive craniotomy should accomplish, the physician must understand the mechanical changes which occur when the pressure within the skull is raised above the normal. In the cranial cavity, the dura mater is in close contact with the inner surface of the bones of the skull — the whole forms, in the adult, a chamber of constant size with firm unyielding walls. Within this thick walled cavity lies the great central organ of the nervous system — the brain.

If from any cause the intracranial pressure is raised, either the bony wall must yield, as occurs in infancy, or the intracranial contents must become compressed. If this latter condition obtains, the diminution in the volume of the brain is mainly due to the emptying of the blood-vessels and the squeezing out of the fluid, unless there is actual destruction of nervous tissue.

The first effect of a local increase of pressure is that the brain is pushed in another direction. Thus in supratentorial new-growths, the hemisphere is pushed toward or away from the median line. As a result, the falx cerebri may bulge toward the other side, and the tentorium become convex toward the cerebellum. The increased pressure upon the inner surface of the skull may be followed by absorption of bone in one or another location. A certain amount of pressure is transmitted below the falx to the hemisphere of the other side; its amount will depend upon the location of the growth. From the same cause, cerebrospinal fluid is forced out of the cranial chamber into the spinal canal and along the sheaths of the cranial and spinal nerves. The stretching of the dura probably causes the headache, and possibly the nausea and vomiting; the forcing of fluid into the sheaths of the optic nerves is followed by papillœdema and choking of the discs while the pressure upon the brain itself is followed by slowing of the pulse and respiration and interference with function. Unless the cerebral ventricles become distended by an obstruction of the iter the fluid is present in excess in the spinal canal.

If a local increase of pressure occurs underneath the tentorium, the latter is bulged upward, and secondarily the intracranial pressure is raised by the stagnation of fluid in the ventricles. The free communication between the ventricles and the subdural spaces of the brain and cord is a necessity for the proper functionizing of the brain; when the cerebrospinal fluid can no longer flow from the lateral ventricles through the Sylvian aqueduct to the fourth ventricle and the spinal canal, symptoms of increased intracranial pressure are certain to appear.

If the increase of intracranial pressure is due to a dilatation of the ventricles, from compression of or adhesions in the iter (obstructive hydrocephalus), from an oversecretion of cerebrospinal fluid or diminished absorption from the subarachnoid space (non-obstructive hydrocephalus), then the pressure will be exerted upon all parts of the brain; although some parts, either on account of a more exposed position or greater delicacy of structure or greater sensitiveness, are more easily affected than others.

The symptoms of increased intracranial pressure are then either local, due to a direct effect upon parts of the brain whose functions are interfered with, or general. Local symptoms are, however, often due to a general cause, and general symptoms are often caused by a strictly local process. Certain focal symptoms such as abducens palsy and nystagmus are often observed in a

[1]Read at the meeting of the Brooklyn Neurological Society ,April 5th, 1916.

generalized increase of tension, and the frequency of cerebellar symptoms in internal hydrocephalus is well known.

A localized expanding lesion such as a tumor or hæmorrhage may first cause focal symptoms, followed by symptoms of pressure on more distant parts of the brain, and finally general symptoms such as loss of consciousness, headache, papillœdema, etc. The progression of symptoms may not occur in such a regular order. The general may appear long before the localizing symptoms, and it is often necessary to operate for the relief of the general symptoms before any localizing ones have shown themselves.

It is unnecessary for me to speak of these general symptoms before this audience — the choked disc, headache, vertigo, nausea, vomiting, ataxia, convulsions, etc., those distressing evidences of increased intracranial pressure from disease or injury, which even if the radical removal of their cause is impossible, so often demand a palliative operation for their relief.

The means at our command for diminishing increased intracranial pressure consists either in the removal of fluid by spinal or ventricular puncture (including puncture of the corpus callosum), or the making of an opening in the skull to give the brain a chance to bulge out through the opening, thus making what really amounts to an enlargement of the cranial cavity.

If the increase of intracranial pressure is due in part, even if only secondarily, to an increase of fluid within the ventricles, the repeated removal of the fluid by lumbar puncture may be a valuable decompressive method. To have any real effect, it is necessary that the communication between the brain cavities and the spinal subdural space be wide open. If this is the case, the removal of 20 to 50 cubic centimeters of fluid at regular intervals, will relieve the compression of the brain to the extent that the compression was due to the fluid. The same can be accomplished by repeated ventricular punctures in infants and young children. Statistics have shown that fully 75 per cent of tumors of the brain are accompanied by more or less internal hydrocephalus, so that in irremovable or unlocalized new-growths, *except those in the posterior cranial fossa*, some relief of the compressed brain will follow the withdrawal of fluid from the spinal canal. Where the increase of pressure is due to an oversecretion of fluid or a diminished absorption from the subarachnoid space, repeated lumbar punctures may be of benefit. If the distention of the ventricles is due to an obstruction of the aqueduct of Sylvius by adhesions, the usual form of primary obstructive hydrocephalus, a new communication may be made between the ventricles and the cerebral subarachnoid space by means of puncture of the corpus callosum. This is a most valuable decompressive operation in all forms of obstructive hydrocephalus, whether due to new-growth or other cause. The investigations of Dandy and Blackfan have shown, however, that it is always necessary to test the absorptive power of the subarachnoid space by means of intraspinal or intracranial injections of neutral phenolsulphonephthalein. If the absorption from the subarachnoid space is far below the normal, there is no use of performing a callosal puncture because the fluid cannot be absorbed and instead of an internal hydrocephalus there would result a combined internal and external hydrocephalus with the same total amount of pressure upon the brain-tissue.

As I shall mention later, puncture of the corpus callosum is a most rational and valuable decompressive method in brain tumors with internal hydrocephalus; it may be done alone or in conjunction with a decompressive craniotomy.

It seems to me that up to the present time we have paid insufficient attention to the lines of force along which the brain-tissues are being dislocated after a decompressive operation. The best decompression will be the one in which the brain-tissue is dragged upon or pushed in such a way that the smallest number of nerve tracts are interfered with. I have examined the brains of a number of patients who have died from irremovable brain-tumor and on whom a palliative subtemporal decompression had been done. In supratentorial lesions there was often considerable internal hydrocephalus, and the

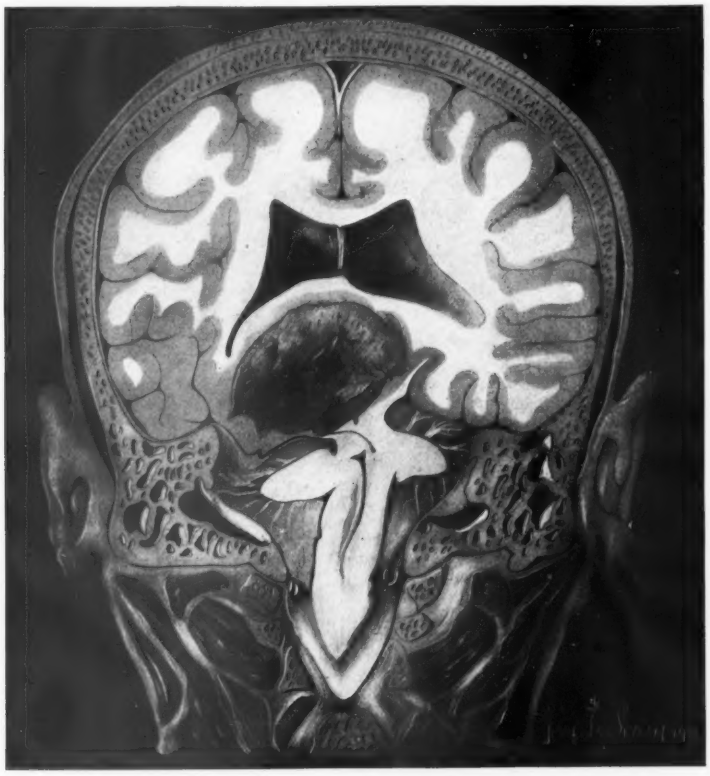


Fig. 1. Midbrain tumor with hydrocephalus (diagrammatic). The symptoms of tumors in this location are apt to be made worse by a right subtemporal decompression. A bilateral subtemporal decompression with puncture of the corpus callosum is the best decompressive operation.

distended lateral ventricle of the side operated on was dragged upon or distorted. Much harm was surely done to important nerve tracts by this unnecessary distortion of the brain, and just as much space would often have been gained, and mechanically a more correct decompression have been accomplished by means of autodrainage of the ventricles. Motor-tract symptoms are apt to be made worse in a left or right mid-brain tumor by a subtemporal decompression on the right side. The symptoms of a tumor which lies medianward to the internal capsule may be exaggerated by a subtemporal decompression. In these two classes of cases, it is advisable to do a bilateral decompression, the right side being done first and the ventricle punctured, so as to avoid too great a prolapse of the left temporal lobe and a resulting aphasia. I am not at all certain that bilateral subtemporal decompression is not a better procedure than unilateral decompression. I have seen many good results, greater and more rapid relief in advanced cases, from bilateral subtemporal decompression, so that I am performing a bilateral operation much more often than I did a few years ago. In subtentorial decompressions a puncture of the corpus callosum or at least a ventricular puncture should always precede the opening of the dura.

From all I have said, it must be clear to you that it is wrong to think that a decompressive craniotomy always means a right

Fig. 2. Large tumor in the right temporal lobe with marked internal hydrocephalus. The best decompression would be obtained by a right subtemporal decompression with a puncture of the corpus callosum.

subtemporal operation. The correct decompression is an operation or combination of operations so planned that the least disturbance will be done to the brain-tissue beyond what has already occurred.

The incision of the capsule of a large irremovable tumor in the cerebellopontine angle and the curetting away of part of the tumor after a large bilateral suboccipital craniotomy has been done is also a decompression. These tumors in the cerebellopontine angle are benign in character, are encapsulated, and grow very slowly. Small tumors can be removed with relatively small danger. Many of the growths are very large when they finally come to operation and markedly compress the pons and medulla, so that even with the greatest care considerable trauma to those important structures is bound to occur. It is therefore preferable to relieve the pressure by incising the capsule of the tumor and scraping out part of the growth, and this will often be followed by complete disappearance of the symptoms. If the symptoms should recur, the procedure can be repeated after a few years.

I have often been asked to state what symptoms demand a decompressive craniotomy. While it is difficult to make any definite statements, the following will sum up my views on the subject. In unlocalizable new-growths, a decompression should be done either for the relief of the headache and vomiting or as soon as definite swelling of the optic discs

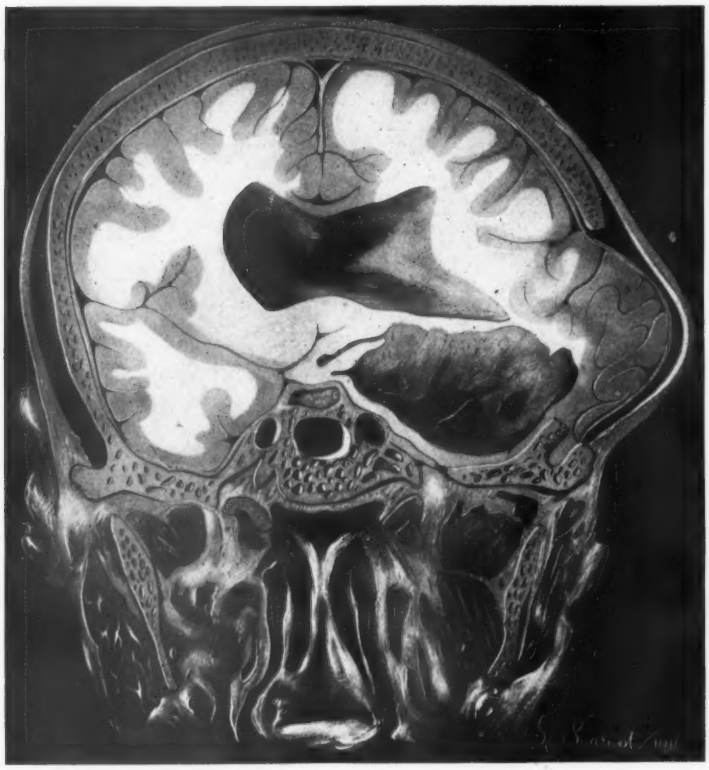


Fig. 3. To indicate the distortion of the ventricle that would occur in a tumor located as in Fig. 2, if only a right subtemporal decompression had been performed.

occurs. Unfortunately it is still the custom to delay operative interference until the papillœdema is a very marked one, often until a marked deterioration of vision has occurred. I have operated upon some patients in whom, in spite of the decompression, vision has become worse and, indeed, upon one in whom it was lost. These patients all had advanced grades of papillœdema, with extensive exudates and much connective-tissue proliferation, so that, in spite of the decompression, the connective-tissue contraction produced sufficient atrophy to deprive the patient of his remaining eyesight. The time will soon come, I hope, when choked disc will be considered a late and not an early symptom of brain tumors. In irremovable tumors of the brain, the decompression, whether subtemporal, suboccipital, puncture of the corpus callosum, or a combination of two of these procedures, must often be done as soon as the surgeon has determined that the nature or location of the growth precludes the possibility of its removal.

In removable growths, there is often an advantage in diminishing extreme intracranial pressure by a ventricular puncture, a puncture of the corpus callosum, or a subtemporal decompression before the actual removal of the growth is attempted. Some of the most successful tumor removals in my experience have been from patients in whom I had performed, as a preliminary, one of the decompressive procedures above alluded to.

What can be promised the patient with a

disease which has caused a prolonged period of intracranial tension?

There are some states of increased pressure in which decompressive operations are useless and should never be tried. The headache, vomiting, and papillœdema of nephritis cannot be relieved by surgical interference on the skull and all the efforts made in this direction have been surgical failures. Cushing once highly recommended decompression in the choked discs of albuminuric retinitis, but the operation rarely had a beneficial effect; in two patients from my own experience, the results were negative. Similarly, in meningitis, the operation has failed to relieve and should be abandoned. The same is true of the attempt to relieve a long standing epilepsy, especially of the Jacksonian type, by a decompressive operation. Various methods have been recommended for this purpose: Kocher and others once highly recommended the operation. But the failures were so many and the benefits from the operation so temporary that the operation has been given up by those most experienced in cranial surgery. And yet, there is a germ of truth in the idea of decompression in epilepsy. I learned this some years ago, when I had occasion to observe a patient upon whom a small right subtemporal decompression had been performed by another surgeon, in the attempt to relieve a Jacksonian epilepsy. The patient informed me that a number of hours before he would have his epileptic attack, the bulging at the site of the operation would become much larger and more tense. This led me to investigate the subject. I found that six to eight hours before an attack, the patient's blood-pressure would rise from 110 to 160, and the hernia would become larger and more tense. I enlarged the subtemporal opening and did a left subtemporal decompression in addition. The Jacksonian fits never returned. I have investigated the subject thoroughly in other patients and have found that occasionally a definite rise in blood-pressure precedes by a number of hours an epileptic attack. These are the only patients with epilepsy, not due to organic lesions, whom I would operate upon. In these patients I have made a large unilateral or bilateral subtemporal decompressive opening, and I have seen some very satisfactory results from the operation.

In the accompanying tables I have summarized the results in 150 decompressive operations for expanding lesions of the brain, and in series of cases in which one or the other decompressive operation was performed.

A study of these tables will show that the best results were obtained where combined

RESULTS IN 150 DECOMPRESSIVE OPERATIONS

Right subtemporal decompression	68	Marked improvement	48
Bilateral subtemporal decompression	12	Marked improvement	11
Suboccipital decompression	31	Marked improvement	16
Puncture of corpus callosum	20	Marked improvement	11
Right subtemporal decompression and puncture of corpus callosum; suboccipital decompression and puncture of corpus callosum	19	Marked improvement	15
	150		

IMMEDIATE RESULTS IN 25 SUBTEMPORAL DECOMPRESSIONS

BEFORE OPERATION		AFTER OPERATION	
Vision failing	24	Returned to normal	10
Normal	1	Improved	11
		No improved	4
Papillœdema 1 D or less	5	Completely subsided	11
Papillœdema 2–3 D	11	To 1–2 D	8
Papillœdema 4–6 D	9	No effect	6
Headaches	19	Gone	13
		No improvement	6
Vomiting	23	Gone	16
		No improvement	7
Convulsions	5	Gone	3
Coma	4	Coma persisted in	4
Paralysis or weakness	4	Improved	2

RESULTS IN 10 SUBOCCIPITAL DECOMPRESSIONS

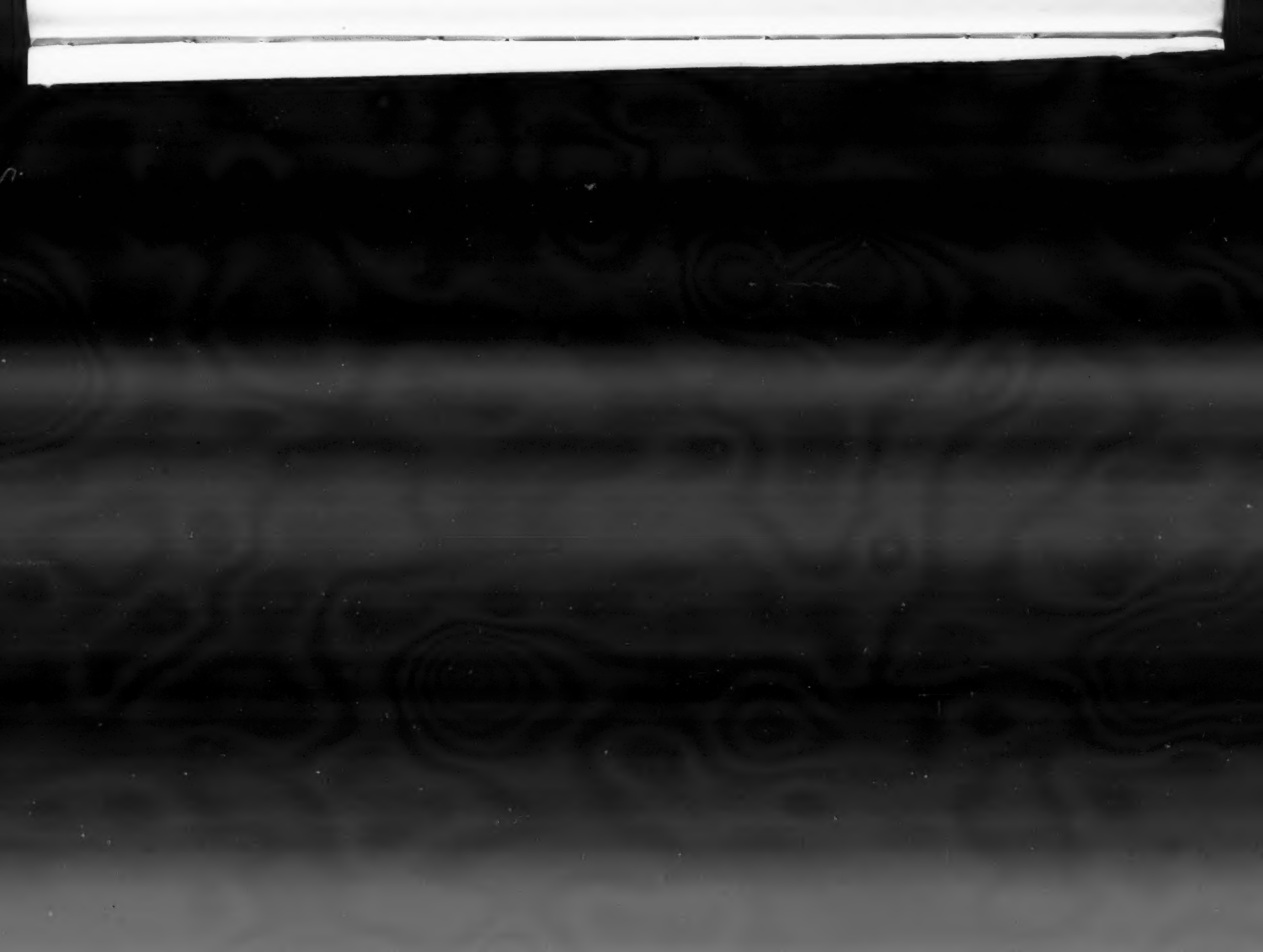
BEFORE OPERATION		AFTER OPERATION	
Vision failing	10	Returned to normal in	3
		Improved in	6
		Not improved	4
Papillœdema more than 3 D.	9	Completely subsided	4
		To 1–2 D	5
		No effect	1
Headaches	10	Gone	2
		Improved	8
Vomiting	10	Gone	10
Ataxia	10	Gone	1
		Improved	6
		Not improved	3

RESULTS IN 10 CASES OF PUNCTURE OF CORPUS CALLOSUM

BEFORE OPERATION		AFTER OPERATION	
Vision failing	10	Improved	6
		Not improved	4
Papillœdema 4 D or over	6	Completely subsided	5
Atrophy	4	No effect	1
Headache	5	Gone	3
Stupor	2	Became conscious	2
Ataxia	5	Improved	3

RESULTS IN 10 COMBINED PROCEDURES

BEFORE OPERATION		AFTER OPERATION	
Vision failing	10	Improved	10
Papillœdema	10	Completely subsided	9
		No effect	1
Headache	10	Completely subsided	9
Vomiting	9	Stopped	9
Ataxia	3	Improved	2
Stupor	1	Improved	1
Paralysis or weakness	4	Improved	3



operations,— bilateral subtemporal decompression, right subtemporal decompression with puncture of corpus callosum, bilateral suboccipital decompression with puncture of corpus callosum, etc.—were done.

If vision is not too much impaired the eyesight can regularly be preserved. The headache and vomiting can, in the large majority of cases, be entirely relieved. Unless the lesion actually involves the motor tract, paralysis may improve very much. I have seen a monoplegia disappear entirely within three months, and a hemiplegia become so much improved that the patient was able to walk again without difficulty and to use his upper limb for all purposes.

Except in cases of direct pressure upon the optic nerves or optic tracts without papillœdema, I have never seen a patient blind for twenty-four hours, recover sight even with the rapid subsidence of the papillœdema. The hope that some vision can be restored by a decompressive operation (or the actual removal of a tumor) is in my experience vain. In double choked disc the danger signals are fleeting attacks of blindness lasting perhaps only a few moments at a time.

It is rarely possible to revive a patient who is in deep coma from a brain tumor by any kind of an operation unless the coma is due to the distention of the ventricles. Therefore, if the neurologist sees a patient with a brain tumor in coma, he should recommend a rapid aspiration of the ventricle or a puncture of the corpus callosum, perhaps with a subtemporal decompression. If there is not a decided increase of fluid in the ventricles, the chances for return to consciousness are slight.

Whether a decompressive operation can really relieve a spastic paralysis (as occurs in Little's disease or in post-hemiplegic spasticity), unless an actual cystic collection of fluid is found, is still an open question. Sharpe claims to have obtained some good results from decompression in Little's disease, and he has shown a number of remarkable cases. If further experience will substantiate the results thus far obtained, a great advance in the treatment of Little's disease has been made by Sharpe.

If the principles laid down in the foregoing remarks are used as a guide for the treatment of fractures of the skull, little difficulty should be encountered.

Fractures of the skull form about 5 per cent of the fractures admitted into the hospital. In spite of this relative infrequency, the difficulties of diagnosis, the many associated complications and the question of proper treatment, invest this subject with special interest.

The chief importance of a fracture of the skull arises from the injury caused to the brain and to the other cranial contents (nerves and blood-vessels). A consideration of some of the effects of fracture of the cranial bones will therefore have to deal mainly with the symptoms due to brain or nerve disturbance, and in order to understand the symptoms a good knowledge of the mechanics of the skull is necessary.

A thorough understanding of the mechanism of fracture is important for the recognition of the extent of the break in the individual case and therefore for the correct treatment. When either a simple fissure, a comminution of fragments, or a depression of bone occurs at or near the point of impact on the skull, there is more apt to be a localized injury to the brain; while if the fracture lies at some distance from the point of impact, the entire brain is apt to be contused with multiple hæmorrhages in the substance and on the surface of the brain. Of course, combinations of the two may and often do occur.

When the fracture of the base is due to a direct impact, as after a fall on the feet or a violence to the top of the head transmitted to the base, the injury to the brain is apt to be very severe, and a fatal outcome not much delayed. Bursting fracture extending into the base of the skull is less often attended with extensive brain lesions, and recovery from this variety of fracture is not so very infrequent. Intracranial nerve lesions are fairly often met with in both these varieties of cases.

Many surgeons incline to the view that all fractures of the skull should be operated upon; that an exploratory incision will do no harm; that a positive diagnosis can be made only

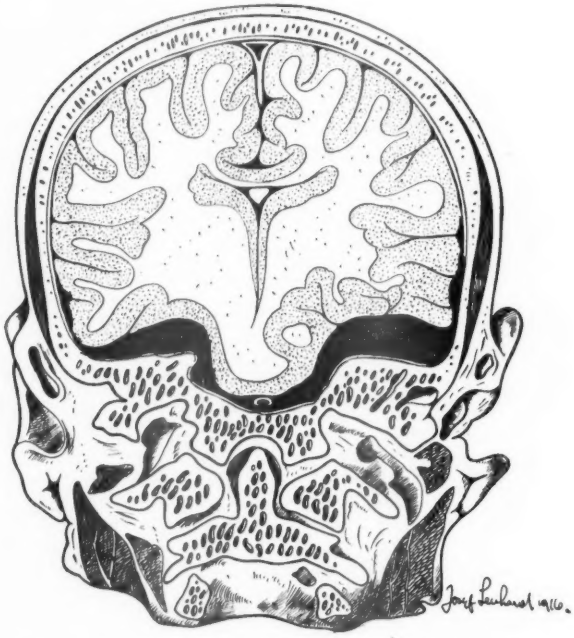


Fig. 4. Large basilar hæmorrhage with fracture of the base of the skull.

by that means; that post-traumatic epilepsy is less frequent when fractured bone — even if there is no depression — is removed.

It has been my experience that the immediate and remote results of conservative treatment are very satisfactory, and I can see very little reason why a fracture of the skull without dislocation of the fragments and with few if any brain symptoms should be operated upon.

The indications for operative interference in fracture of the skull should be based upon the diagnosis of the condition present in the individual case, and upon the question whether there is a stationary or an advancing lesion. The fact that the patient is drowsy or in a stupor is not of itself an indication for operation, for an individual with so-called cerebral concussion without bony fracture or gross injury to the brain may remain in a stuporous condition for many hours. It is a different matter if the stupor becomes deeper and if more and more evidence of increased intracranial pressure appears.

Congestion of the retinal veins and slight pinkish color of the discs occur with great frequency after simple fissured fractures of the skull, but if frequently made ophthalmoscopic examinations reveal increasing changes in the fundi, we may be certain that the intracranial lesion is advancing.

That an individual has a weakness or paralysis of one or more limbs immediately after having sustained an injury to the head, does not mean that operation is indicated, for the operation will often fail to show a lesion that can be remedied by the surgeon. On the other hand, the progression of the symptoms, weakness increasing up to complete paralysis, twitchings increasing up to convulsions, is an evidence of an advancing process in the cranial cavity.

Nor is it necessary or advisable to operate upon every patient who presents symptoms of fracture of the base of the skull. If there are no evidences of greatly increased intracranial tension, operation can be safely delayed; if symptoms due to pressure from

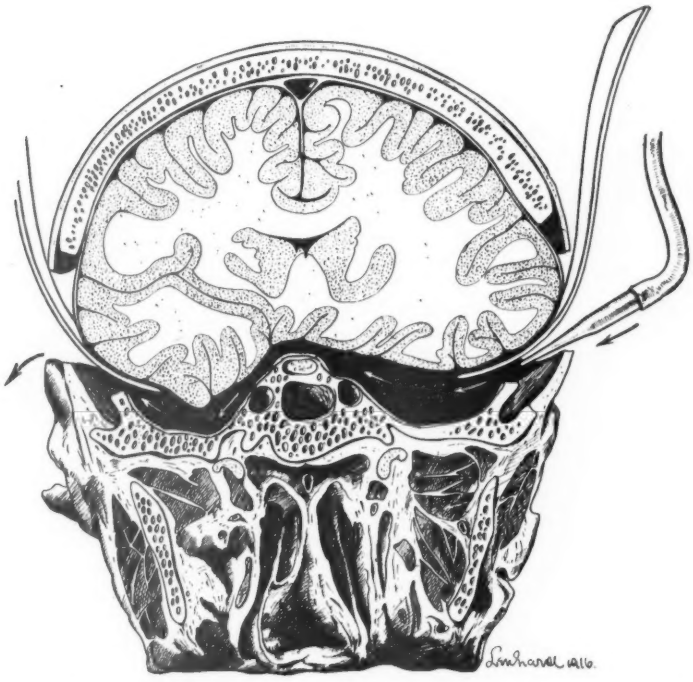


Fig. 5. The method used for washing out the blood and clots from the base through a bilateral subtemporal opening.

blood or from œdema of the brain-tissue appear, there is always time enough to perform a decompressive operation. The surgeon who performs well-timed rather than immediate operations will be bound to have the best results.

I have become accustomed to group patients with fractures of the skull into the following classes:

1. Patients with evidence of fracture of the vertex with few or no brain symptoms, no loss of consciousness, no twitchings, paralysis, or convulsions. These patients need not be operated upon, but they must be carefully watched for the appearance of new symptoms. At any time during the course of a number of days after the head injury, they may develop signs of cerebral compression due to slow venous bleeding or to œdema of the brain. The pulse and respirations must be taken at short intervals and the eye grounds carefully examined every few hours. If the symptoms show a tendency to progress and are well localized to one part of the brain, the surgeon may be in doubt whether there is increasing extradural or intradural hæmorrhage. An exploratory puncture of the skull may then have to be done, and it can often be accomplished under local anæsthesia. A small drill hole is made through the soft tissues of the scalp and the bone, and a blunt pointed aspirating needle is passed through the drill hole, until the dura is reached. If aspiration fails to reveal blood, the needle is pushed through the dura and aspiration is again done. By this means we are able to determine with certainty whether there is any considerable collection of blood inside or outside of the dural sac. If the symptoms become more marked, an exploration or a subtemporal decompression may become necessary.

2. Patients with partial or complete loss of consciousness, weakness of one side of the

face, marked weakness or paralysis of the upper or lower limb of the same side or of both limbs, exaggerated tendon reflexes with ankle clonus, slow pulse and respiration. These patients have either a marked depression of bone or a large extradural or intradural collection of blood, and must usually be operated upon. The operation that must be done is either removal of depressed fragments of bone, removal of extradural extravasation of blood with ligature of a bleeding middle meningeal artery, or incision of the dura with removal of a subdural collection of blood and treatment of lacerated brain-tissue. If none of the conditions just mentioned is present, a subtemporal decompressive operation should be done.

3. Patients with few symptoms but with hæmorrhage from ear or nose, etc.

4. Patients in whom few symptoms are present at first, but who develop after a few days signs of increased intracranial pressure-papilloedema, drowsiness, respiratory disturbances and slow pulse. The symptoms are due either to slow venous hæmorrhage or to œdema of contused brain tissue. If the signs point to a localization of the compression of the brain, an exploratory trephining must be done over that region; otherwise a subtemporal decompression is indicated.

5. Patients with the signs of fracture of the base. As soon as any symptoms of increased intracranial pressure appear, a subtemporal decompression must be performed.

Through the subtemporal opening it is often possible to wash away considerable blood-clots from the base by means of an irrigation with saline solution. For this purpose the irrigating tip is gently pushed underneath the temporal lobe and the stream of solution allowed to flow in slowly. I have several times, by means of a bilateral subtemporal opening, washed out many blood-clots from the base of the middle cranial fossa.

IMMEDIATE AND REMOTE RESULTS OF FRACTURE OF THE SKULL

What are the immediate and remote results of a fracture of the skull?

Fractures of the vault operated on or not operated on, very frequently leave the patient for years in a depressed mental condition and quite often the patients are useless for the work they have formerly done. They have lost their former energy, complain of a number of functional disturbances, and in short suffer from post-traumatic neuroses. Thus I have seen a structural iron worker unable to return to his work for years, feeling uncertain about himself; the skilled mechanic no longer able to do his artisan's work; the typist "too nervous" to return to her vocation. These traumatic neuroses are of considerable importance from the medicolegal standpoint, patients often being accused of shamming illness.

It has been my experience that a larger number of these patients develop epileptic attacks than do the patients who have not had this post-traumatic mental weakness. Epilepsy follows a skull fracture in 5 to 25 per cent of the patients and is more frequent after fracture of the vault than of the base. And this epilepsy is very difficult to treat and the results of surgical interference are very poor. Unless a local lesion, such as a cyst, is found, the outlook for relief is very small. Division of adhesions between the cortex and the dura or scalp, with the introduction of vaseline, cargile membrane or fat, will only rarely give a satisfactory result. The convulsions are often due to cicatrices in the brain tissue. The physician must not be misled by the fact that the convulsions do not recur for a few months after the operation. It is well known that epileptic seizures will cease for a time after any operation, but sooner or later, after three, four, or six months, they recur.

Conservatism, therefore, is indicated in fractures of the skull and there must be definite signs of brain lesion or symptoms of increasing intracranial pressure, before surgical interference is instituted. Excluding patients with depressed fractures or with large meningeal or subdural hæmorrhages, I have collected from my records 60 cases of skull fracture that either were not operated upon or in whom a decompressive operation has been performed. I have excluded all those with gross lesions, whether depression of bone, laceration of the longitudinal or transverse sinus, and the like; although in every patient

who is operated upon, except where the only lesion is an extradural hæmorrhage, a decompressive opening should be left after the cause of the increased pressure has been removed.

Of the 60 cases of fractured skull, 24 or 40 per cent recovered without operative interference, although many required most careful watching and in some we were in doubt for many hours as to the need of a decompression. Fourteen, or 23 per cent, were moribund when admitted to the hospital and their condition never improved sufficiently to allow an operation, even without anæsthesia. Twenty-two patients were operated upon and a unilateral or bilateral subtemporal decompression was performed. Seventeen patients recovered and five died. The deaths in every instance were due to extensive and hopeless laceration of the brain. In a number of the patients, extensive collections of blood were washed out from under the dura.

THE TRANSPLANTATION OF FREE FLAPS OF FAT

A Report of the Results Obtained in Attempts to Prevent Adhesions and Contractures About Tendons, Nerves, Blood-vessels, and Joints, to Favor Repair, and to Lessen Deformity[1]

By ALLEN B. KANAVEL, M.D., Chicago

THE accompanying contribution presents the results obtained by the transplantation of free flaps of fat in an endeavor to prevent the development of scar tissue about tendons, nerves, and blood-vessels, and to restore mobility to scar tissue and joints. It is now five years since some of the patients were operated upon and it is thought that a résumé of the results actually obtained by the author might be of value. Thirty-two patients had been operated upon previous to the year 1916. The details of various cases are not presented except in so far as is necessary to emphasize the individual points. Where pictures could be obtained that would demonstrate the results they are presented. Naturally the earlier cases operated upon show less favorable results than those dealt with after the technique was developed.

The fat was generally obtained from the abdominal wall, although if the patient were excessively obese or if the fascia lata was transplanted simultaneously the leg was found preferable.

The thickness of the flaps varied from one-fourth inch to one inch and either seemed to live without difficulty if the field was aseptic, and in two instances the transplants have persisted in spite of infection; once when the primary wound became infected and in a second instance when the fat was transplanted into an infected area.

Where possible no sutures were used to retain the flap in position and care was taken to prevent the development of a hæmatoma in the field.

Transplantation of Fat into Cicatrices to Soften Them, Restore Mobility, and Repair Deformity

Four cases have come under my observation in which this procedure was available. The photographs here presented of a patient (Wesley Memorial Hospital No. 47,223, Fig. 1) illustrate the general type of these cases and the results to be obtained.

The patient had suffered a burn of the face in childhood which resulted in a severe scar-tissue contraction of the lower part of his face and the neck. As a consequence the lower lip was everted and drawn down so that the lower teeth could be covered only by the upper lip and the saliva constantly drooled from the mouth. The lower lip and the adjacent tissue on the chin and under the jaw were of boardlike rigidity. Two operations were performed. At the first a X-shaped incision

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was made from the point of the chin downward. The entire lower portion of the face including the shriveled lower lip and adjacent tissue was mobilized. This allowed the cicatricial lower lip to be raised so as to cover the teeth, but it was still everted and immobile. Consequently at a second operation a small V-shaped incision was made beginning one inch from the free border of the lip and in the median line and going upward for one-half inch. With a small scalpel the scar tissue was undercut in all directions for the distance of about an inch, and a flap of fat one-half inch in thickness was transplanted from the abdomen and the wound sewed in Y-shape, thus correcting the eversion of the lip. The result was astonishingly satisfactory. The entire lip became mobile; was greatly softened; and as can be seen by the photograph is cosmetically satisfactory. The pictures were taken two years after the second operation at which time there was no evident absorption of the fat; moreover, at the end of the first year a slight incision was made at one corner to raise the angle of the mouth slightly and fat was found in the area to which fat had been transplanted and it was assumed that this was the same fat previously placed there. Unfortunately no photograph was secured before the operation. The accompanying photograph showing the lip turned down and everted by the tenacula represents an endeavor to simulate the deformity (Fig. 1).

A second case (Wesley Memorial Hospital No. 50,675) was operated upon for a very similar deformity, except that in this case the lower lip was destroyed by a caustic as a part of a procedure to remove an epithelioma by a so-called cancer specialist. The fat has also remained in this lip but it is too early for a final report.

In two other cases fat was transplanted into scar tissue, once to relieve a marked dimpling of the cheek due to a previous scar with contracture and, again, into an extensive cicatrix over the buttocks which was so extensive as to render plastic covering by skin most difficult. The first was inserted from a small buttonhole incision above the hair-line and was entirely successful. The latter case was not so successful in that the scar broke down at one place and necessitated much after-treatment; a result, I fear, due to technical faults in the operation and not to inherent defects in the procedure. In time healing took place with some improvement but the case was not so successful as the others.

TRANSPLANTATION OF FAT ABOUT VESSELS TO PREVENT ŒDEMA FROM CICATRICIAL CONTRACTION

Four cases fall into this group. In three cases fat was transplanted about the vessels which had been dissected out in radical operations for carcinoma of the breast and once after a radical dissection of the inguinal region for metastatic melanosarcoma. The results in one of the breast cases and the inguinal dissection was all that could be desired, but in the remaining two breast cases the result was not satisfactory.

It had been my custom to leave a three-inch slump of the pectoralis major to cover the vessels after the method described by Dr. Murphy, but the anatomical proof of the possibility of carcinomatous metastasis here seemed to demand some method free from this possibility, in spite of the fact that such a result had not happened in my limited experience.

In the first case (Wesley Memorial Hospital No. 44,281, Fig. 2) a flap of fat three inches in diameter, four inches in length, and one inch thick was taken from the abdomen, laid over the vessels, and sutured in position by four light catgut sutures, and the wound closed in the usual manner. The healing was satisfactory, no œdema developed, and now, after two years, examination discloses a fair amount of the fat still in position. There is surely no evidence of cicatricial contraction.

The second case (Wesley Memorial Hospital No. 47,377) in which the transplant was used by the same technique, the wound became infected and the fat was extruded by the end of ten days. The technique was no different than in other cases and while infection is always possible it seemed to me that the result was in some measure favored by the transplant.

However, a third case (Wesley Memorial Hospital No. 47,553) was treated in like manner. Here a low-grade infection developed after some days, and while the flap did not slough out *en masse* there was a constant discharge of fatty serum which doubtless ultimately removed the efficient part of my transplant.

Again, it seemed to me that the transplant was a source of difficulty and no more cases were subjected to this technique. It may be that if smaller or thinner flaps had been used the result might have been different, but it would seem that a transplant into such a large wound in which some bacteria are surely always deposited is attended with considerable risk, since it is the common experience that such cases almost always heal without infection if performed after the usual technique. In fairness to the procedure it should be noted that four successful cases of transplantation of fat under the skin following breast amputation have been reported from Klapp's Clinic; Judd and Czerny also report cases.

The dissection of the inguinal region (Wesley Memorial Hospital No. 51,456) with subsequent transplantation of fat over the femoral vessels was one in which an extensive dissection was done; the inguinal region stripped clean, Poupart's ligament cut; and the iliac and adjacent pelvic glands and fat removed. A flap of fascia lata with a large flap of fat attached was transplanted. The fascia lata reinforced the cut Poupart's ligament and the fat-flap covered the vessels and nerve. The wound healed without reaction and no bad effects have been noted after one year of observation.

TRANSPLANTS ABOUT NERVES TO PREVENT SCAR-TISSUE CONTRACTION AND FAVOR REPAIR

My personal experience falls into two groups. The first, those cases presenting themselves with a severed nerve with or without previous local infection, and the second, those cases in which the nerve was dissected out of scar tissue incident to the attempt to relieve old contraction following antecedent infections. The second group, comprising four cases, will be considered later under the "Contractures Following Infections." The first group comprises five cases.

CASE 1. Cook County Hospital No. 515,698 was operated upon in July, 1913. The patient had suffered from an incised wound above the elbow of the left arm three weeks before being admitted to my service and presented anæsthesia over the area of ulnar sensory distribution and a paralysis of the muscles supplied by the nerve. After waiting ten days to allow the local infection which was present to be eradicated, the nerve was dissected out of the scar tissue and united by perineural fine silk suture. A pedicle of fat was dissected from the adjacent flexor surface and wrapped about the nerve, being held in position by a fine silk suture.

The tissue contained little fat and I fear did not give as satisfactory a bed as would have been secured by a free transplant. However, the wound healed without infection and upon examination (April, 1916) presented fully 90 per cent of sensation over the entire area of ulnar sensory distribution. The patient recognized a light touch of cotton everywhere but at times said, "It feels queer." The skin had the normal color and tone. Adduction of the thumb was perfect. There was no evidence of paralysis of the nerve except that the little finger lumbrical seemed to be impaired in its function (see Fig. 3). There was no evidence of muscular loss in the interossei although the interosseous spaces seemed less full than those of the other hand.

CASE 2. Wesley Memorial Hospital No. 27,831. This patient suffered a fracture of the right elbow in 1912 and following the injury paralysis of the ulnar was present. The nerve was dissected from the scar three months after the injury and wrapped in a free transplant of fat from the abdomen. The patient has not been examined by myself but reported in 1914 that the hand was perfect in function and sensation. He was a college student and the report would seem to be reliable.

CASE 3. Wesley Memorial Hospital No. 50,268 (Fig. 4). This patient was injured in a sawmill. The entire flexor group of tendons and the median and ulnar nerve were severed at the lower third of the arm. At the time of the accident three deep sutures were used to close the wound, no attempt being made at union of the tendons or nerves. Severe infection ensued. Six months after the injury the patient presented the atrophic and immobile hand characteristic of this condition. The nerves and tendons were dissected free and the tendons united in the usual manner by silk. The ends of the ulnar nerve after being freed could be approximated and were sutured by a perineural silk suture. In the case of the median nerve, however, even after freeing the ends for some distance there was still a separation of one and a half inches. A vein was removed from the leg and through it were drawn several strands of fine silk uniting the two ends of the nerve, the vein enveloping the ends of the nerve as well as the silk. Fat was dissected from the abdomen and one flap one-quarter inch by two inches by three inches placed under the flexor profundus tendons, a flap of similar size was wrapped about the two nerves thus separating the flexor sublimis and flexor profundus tendons. No flap was placed superficially. The skin was closed by clips. The wound healed without infection and the patient left the hospital in two weeks. I have not been able to examine this case myself, but a physician of his town who examined him at my request 16 months after the repair, writes me that the result is entirely satisfactory; sensation is present and while the hand is somewhat weak he is using it every day as a mill hand. The photograph (Fig. 4) shows the result at this time.

CASE 4. Wesley Memorial Hospital No. 50,951 (Fig. 5). This patient has not been under observation long enough to give a satisfactory statement as to his final result. Careful observation is being made, however, and since he is under constant observation the final report should be reliable. In many ways it is worthy of study. He received a cut upon his wrist nine years before presenting himself. Examination showed a complete loss of sensation over the distribution of the median nerve below the injury. The distal phalanges of the index and middle fingers are atrophic and show scars of many injuries and burns. The thumb cannot be abducted;

nor can the distal phalanx of the thumb be flexed. Operation showed that the stump of the flexor longus pollicis had been united to the end of the median nerve.

The nerve and the tendons were sutured by the ordinary technique and a free transplant of fat from the abdomen wrapped about the nerves and tendons. The fat remained *in situ* with no infection, but one month after leaving the hospital a small sinus appeared and persisted until one of the silk sutures was removed under a local anæsthetic. This evidently came from the tendon of the flexor longus pollicis since that tendon draws upon the scar when it functionates. The result after one year is shown in the illustration (Fig. 5). It will be seen that the flexor longus pollicis acts perfectly. There is still atrophy of the abductions of the thumb but they seem to have some function. The sensation is certainly returning over the median distribution. The fingers have lost their glossy look and the patient can appreciate the faintest touch with cotton in some areas; in others improvement is evident.

The suture of the median nerve to a tendon is a very common mistake apparently. I have found this in four cases of secondary operation in my service. One of the cases, not reported here since it has not been observed long enough to be of value in this report, presented two distal tendon ends sutured to the median nerve.

Case 5. Cook County Hospital No. 547,415 (Fig. 6). The patient presented an incised infected wound above the left elbow. After the infection disappeared the ulnar, median, and musculocutaneous nerves were cut at the primary operation, the ulnar being dislocated from behind the internal condyle to the front of the forearm. Fat was transplanted and the wound healed without infection. After one year the patient was sought out and the area of distribution of the ulnar and musculocutaneous nerves was found to have perfect innervation, but it was now discovered that the median had been cut at the injury and had not been discovered owing to the scar tissue. This most embarrassing and culpable mistake was corrected by a second operation one year after the injury and fat transplanted about that nerve. The second operation gave us an opportunity to observe the condition about the nerves sutured at the previous operation and the presence of a loose fatty tissue about the nerves was demonstrated to those present. There had undoubtedly been some absorption of the fat, but enough had been preserved to fully answer the purpose. Time enough has not elapsed to speak of the result of a second operation, but the result as it now stands shows perfect regeneration of the ulnar and musculocutaneous. The illustrations presented show the function.

In reviewing these nerve cases no attempt has been made to present a complete report. This will be done in a subsequent report dealing with all of the nerve-suture cases coming under my observation. It is apparent from the statistics reported here that fat can be transplanted about nerves with safety. The fat stays in place and apparently persists in part. At least it surely prevents severe scar-tissue contraction and apparently is a valuable adjuvant in repairing nerve injuries.

TRANSPLANTATION OF FREE FLAPS OF FAT ABOUT CUT TENDONS AFTER SUTURE

Two patients in whom tendons were sutured have been reported in the section above dealing with repair of the nerves. The results in both instances were entirely satisfactory. In three other cases without nerve injury a similar technique was used with perfect result. Two of these are worthy of brief mention.

Case No. 36,928, Wesley Memorial Hospital, presented himself one month after injury to the distal portion of the ulnar part of the palm. The infection which ensued had disappeared upon entrance. Both the superficial and deep tendons of the left ring and little finger were found to be cut and imbedded in scar tissue. They were dissected out and united end to end, fat being transplanted to wrap about them. There was no infection of the wound. After two years the tissue of the palm is soft and function is perfect as will be seen by the accompanying photograph (Fig. 7).

The other case, Wesley Memorial Hospital No. 58,545, Fig. 8, presented herself one year after an attempt had been made out of the city to repair a cut tendon of the flexor profundus of the index finger. The result had not been satisfactory. The function of the flexor profundus was absent. Operation disclosed that the upper end had retracted into the palm and that the synovial sheath was obliterated. An opening was made down to the distal stump along the flexor surface of the middle phalanx. A forceps then grooved a canal through the attachment of the flexor sublimis down to the proximal end. An opening through the sheath here allowed one to fasten this end to a probe and thus draw it through the improvised canal and unite it to the distal part. A free transplant of fat from the abdominal wall was then drawn about the tendon in the canal and the line of suture. That this can be done and the fat not be extruded is shown by the photograph of the patient's hand. Too short a time has elapsed to speak of the ultimate result.

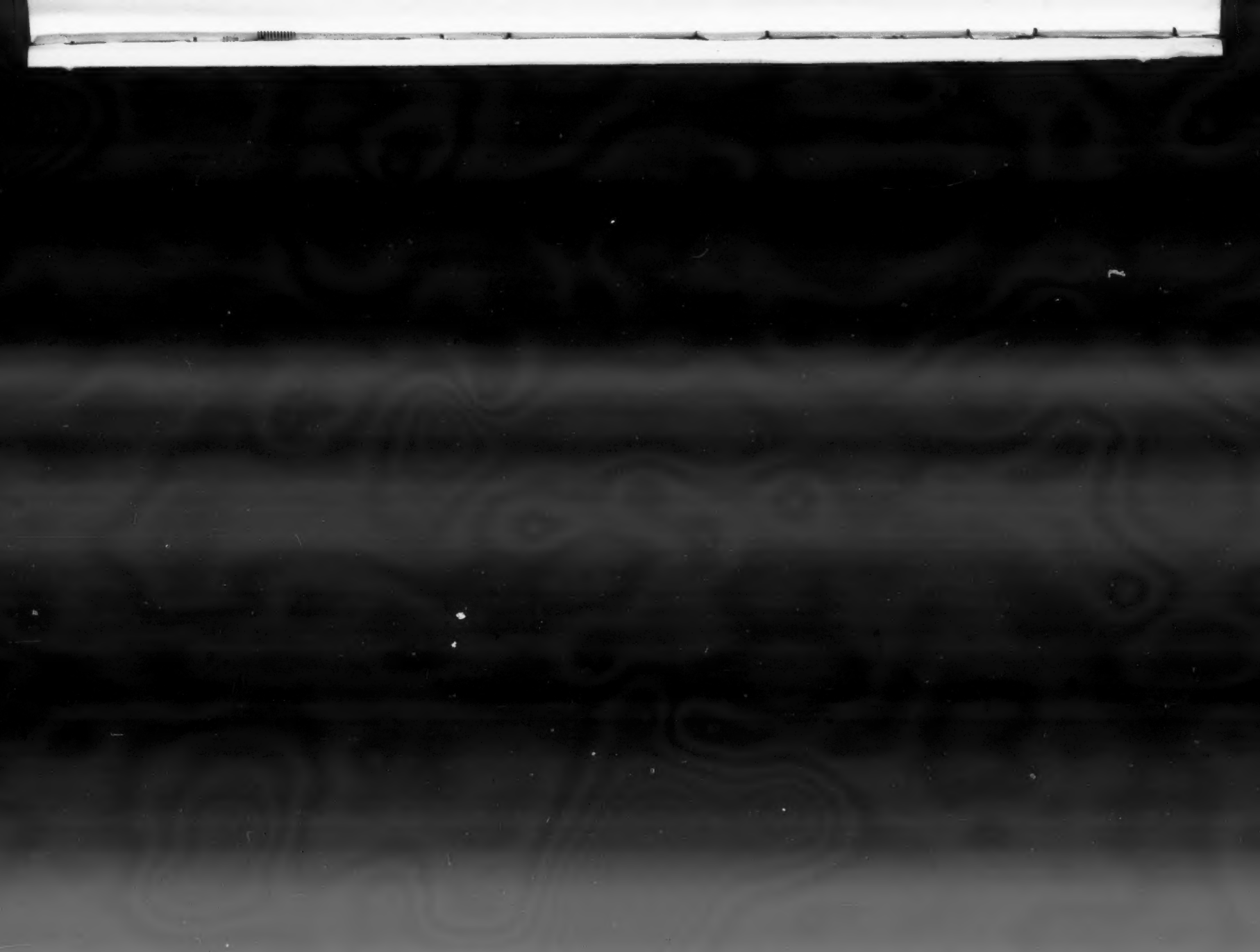

Fig. 1. Wesley Memorial Hospital No. 47,223. Photograph showing result of fat transplant into scar. Photograph on the left shows attempt to represent the deformity since unfortunately no photograph was taken previous to the operation.

The results in these cases prove conclusively that fat can be transplanted in such cases without losing the fat, that it apparently persists in part at least, and certainly prevents adhesions that might interfere with separate functions of the different tendons. It is to be regretted that only one case has been observed in which an attempt was made to produce function along the sheath in the finger and that this has not been observed long enough to speak of the result. In general, however, my experience has been so satisfactory that I shall transplant fat in every case where adhesions about such tendon suture is to be feared.

TRANSPLANTATION OF FREE FLAPS OF FAT INTO JOINTS

My experience here falls into two groups. First, cases presenting tuberculosis of the joint and second, ankylosis following infection. The first group presents two patients with tuberculosis of the wrist-joint. Neither operation was a fair test of the possibility of the use of fat in these cases. The results, however, presented certain valuable data.

The first case, Wesley Memorial Hospital No. 51,865 (Fig. 9), presented himself with tuberculosis of the right wrist-joint showing considerable destruction of the carpal bones and the adjacent articular surfaces. There was present a secondary purulent infection with several sinuses discharging much pus. Without being aware at the time of the previous work of Makkas it occurred to me that possibly if the carpal bones were removed and the cavity left filled with fat the absence of a cavity might favor more rapid recovery. The joint was resected therefore, and a free transplant of fat inserted in the cavity after it had been thoroughly painted with tincture of iodine. The wound was closed without drainage; the sinuses being curetted and left open.

Fig. 2. Wesley Memorial Hospital No. 44,281. Photograph showing result of transplant of fat about vessels and nerves after radical operation for carcinoma of the breast. Picture taken 17 days after operation. Note free motion and fullness over vessels.

The result may be summed up as follows: The fat was not extruded. The sinuses continued to discharge for eight months after the operation, now open and now closed, and finally seemed to be cured, the sinuses having remained closed now for six months. The joint has a range of motion of about 30°. The fingers have not as yet recovered their function.

It is evident that a final report on this case cannot be made at the present time but this much can be said, that fat can be transplanted into such infected joints and not be lost *en masse*, and that in this case it seemed to favor recovery. The illustration (Fig. 9) shows the result after one year.

The second case (Cook County Hospital No. 577,953 Fig. 10) exactly similar in character with profuse purulent discharge was treated in a similar manner, and now after eight months is still discharging and in the opinion of Dr. Jacobs, the orthopedist in charge, and to whom I am indebted for the case, the course has not been changed although it is too early to speak of the ultimate result.

As was stated above these two cases are not a fair test of the procedure in tuberculosis cases. Makkas reports two cases and other authors a few more in which the fat transplant was made with good results into resected tuberculous joints and bones which were not the seat of secondary infection. The field

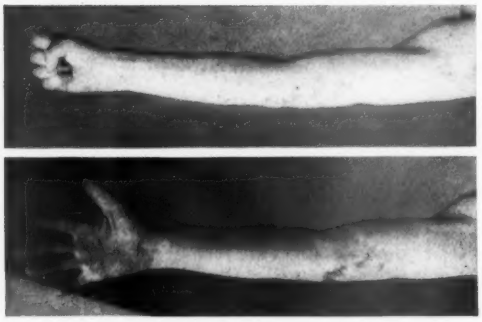

Fig. 3. Cook County Hospital No. 515,698. Result three years after free transplant of fat about ulnar nerve suture.

would seem a worthy one for further investigation as to the methods of resection, the best field for the transplant, and the types of cases in which it may be of benefit.

In relation to the transplantation of fat into infected areas, Rehn reports an interesting case in which he used a free transplant of fat to bridge a defect in an urethra. The fat remained in this infected field, although the patient had an infected bladder and a perineal fistula developed and did not heal for some time.

The second group, the transplantation of fat into resected ankylosed joints has in my hands been restricted to resection of the wrist-joint ankylosed as a result of arthritis accompanying severe infections in the hand. These cases are spoken of later under that caption. The results may be summed up as follows. Where the ankylosis has been little complicated the results have been satisfactory, but as time has gone by some absorption of the fat is evident so that from my observation if the joint resected were adjacent to a muscle-flap this would seem to be preferable. If, however, the joint does not have such contiguous tissue, fat can be transplanted with assurance that it will not be extruded and will give a fairly satisfactory result. On the other hand, if the ankylosis is complicated with scar-tissue contraction of the structures about the joint, the result is naturally affected, but in none of my cases has the ankylosis recurred and in all but one the range of motion as will be seen by the illustrations (Figs. 14 to 16) was from 25 to 45°, entirely satisfactory under the circumstances. In the case spoken of (as presenting an unsatisfactory result) only one row of carpal bones was removed. In all the other cases both rows of bones were removed.

TRANSPLANTATION OF FAT INTO BRAIN DEFECTS

In two cases of traumatic epilepsy, fat transplants have been used. In neither has the result to date been entirely satisfactory. One (Wesley Memorial Hospital No. 46,439, Fig. 11) was lost to observation after one month. He had had one convulsion during that time. The second case (Wesley Memorial Hospital No. 57,355, Fig. 12) was operated upon six months ago and he has had three convulsions in that period, all occurring in two days at the end of three months. Manifestly, he had not been observed long enough to give any definite data. However, it may be said safely that the fat heals in without any apparent irritation. Both of these pads of fat were about one inch in thick-

Fig. 4. Wesley Memorial Hospital No. 50,268. Photograph 16 months after suture of ulnar and median nerves and all the flexor tendons of the forearm with fat transplant. Operation 6 months after injury.

ness and two inches square. Lexer, Rehn, and others report successful cases. I am now engaged in further experimental investigation in this field.

TRANSPLANTATION INTO DEFECTS OF BONE

Here three groups of cases should be considered:

The first, tuberculous cavities in bones. One such case has been operated upon (Wesley Memorial Hospital No. 51,459). The patient presented a tuberculosis of the costochrondral junction of three ribs on the left side. The cartilage and bones were removed and fat transplanted. In the ensuing infection the fat was extruded in droplets and apparently did no good.

The second, non-tuberculous osteomyelitis. In spite of good results reported by others my two cases lost the fat in droplets and it seemed to have no beneficial effect, so that the procedure was abandoned in favor of muscle-flaps.

The third group, osteitis fibrosa cystica. One such case (Cook County Hospital No. 435,688) was operated upon, the cyst curetted out, a fat transplant inserted, and the wound closed. The wound healed without drainage and the X-ray picture seemed to show that calcium salts were deposited in the wall of the cyst. Clinically the leg became strong enough to support the body weight. Just what process ensued in the area is not exactly clear, but in a similar case I would try the same procedure.

Fig. 5. Wesley Memorial Hospital No. 50,951. Photograph one year after suture of median nerve and tendon of flexor longus pollicis with fat transplant. Operation 9 years after injury.

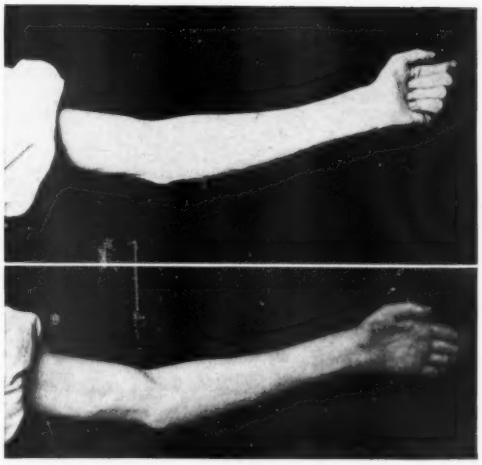

Fig. 6. Cook County Hospital No. 547,415. Photograph one year after suture of ulnar and musculocutaneous nerves with transplant, median nerve sutured at time photograph was taken so no result of this shown.

FAT TRANSPLANTATIONS IN CONTRACTURES OF THE HAND FOLLOWING INFECTIONS

Here the transplantation of fat in the treatment of these cases will be considered with no attempt to take up the various supplementary procedures used. Moreover, only the most severe types will be considered. Photographs will be presented of five cases (Wesley Memorial Hospital Nos. 44,483, 42,049, 42,956, 41,261 and 50,332). Other cases have been operated upon but have not been observed long enough to give absolute data. The pictures will be presented with a composite description of the pathology and results to be obtained. The cases all presented the contracture and ankylosis incident to a combined ulnar and radial bursal infection with a complicating infection of the connective-tissue spaces of the hand and forearm and an ankylosis of the wrist-joint. In these cases the typical useless, immobile, claw-hand is seen.

One who has not operated upon severe cases can hardly realize the extent of the

Fig. 7. Wesley Memorial Hospital No. 36,928. Photograph taken 2 years after operation with fat transplant showing result of suture of both superficial and deep flexors of little and ring fingers. Infection had followed primary injury. Operation one month after injury.

destruction of tissue and the distortion of the anatomical structures found as a result of the infection. In those cases in which the tendon sheaths are involved — and these are by all odds the most serious type one finds — the synovial sheath is entirely obliterated; the endothelial lining is entirely lost; there is a complete fibrous union between the tendon and its sheath throughout its extent, and, incident to the flexed position of the hand and the changes characteristic of all connective tissue, the tendons have been shortened. At the wrist under the anterior annular ligament, the ulnar and radial bursæ and the intermediate sheaths are completely obliterated and the majority of the tendons are indistinguishable as tendons from the surrounding connective tissue. A few of the superficial flexor tendons may be dissected out from this scar tissue and recognized. The flexors of the little finger are frequently

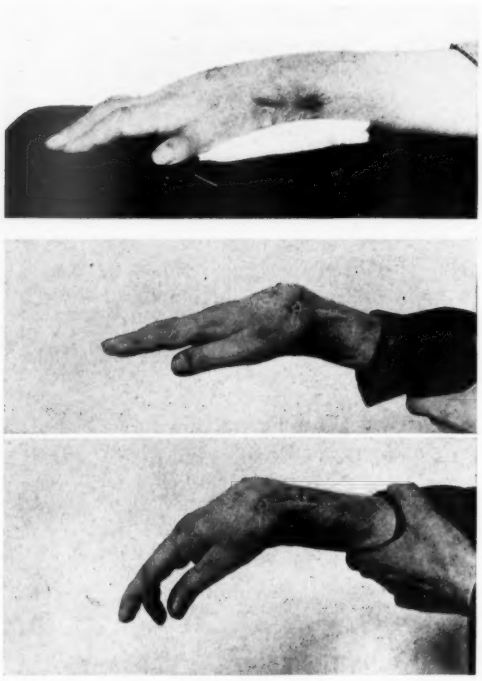

Fig. 9 (below). Wesley Memorial Hospital No. 51,865. Result of transplant of fat one year after operation with removal of carpal bones from a suppurating tuberculous wrist-joint.

Fig. 10 (above). Cook County Hospital No. 577,953. Photograph 8 months after fat transplant with removal of tuberculous carpal bones from a suppurating wrist.

Fig. 8. Wesley Memorial Hospital No. 58,545. Photograph taken 9 days after suture of old cut tendon of index finger with fat transplant.

Fig. 11. Wesley Memorial Hospital No. 46,439. Photograph of patient one month after transplant of fat in traumatic epilepsy.

Fig. 12. Wesley Memorial Hospital No. 57,355. Photograph 2 weeks after transplant of fat in traumatic epilepsy.

Fig. 13. *A*. Wesley Memorial Hospital No. 44,483. Patient had a severe burn with infection and slough of palmar fascia. Infection of ulnar and radial bursæ. Fingers absolutely immobile. No ankylosis of wrist. Injury 12 years previous to operation.

completely lost and the same holds true of the flexor of the thumb. The anterior annular ligament is involved in the connective-tissue formation. In the palm, the tendons of the index, middle, and ring fingers may frequently be isolated and less often those of the little finger and thumb. On the dorsum, particularly if ill-advised incisions have been made here, the tendons are a part of the connective-tissue mass although more easily dissected out than those upon the flexor surface. In the forearm, connective-tissue contraction has taken place about the median and ulnar nerves and the ulnar artery, compressing them and binding the muscles together. Moreover, the tendons above the wrist-joint and the deep flexor muscles are united by firm connective-tissue bands to the pronator quadratus and the interosseous septum.

Joint changes have also occurred. These are noticeable in the interphalangeal, metacarpophalangeal, and wrist-joints. Owing to the inflammation about the phalangeal joints, they are rather firmly fixed in flexion while the metacarpophalangeal joints are generally fixed in overextension, with periarticular contraction and intra-articular adhesions, frequently not insurmountable but

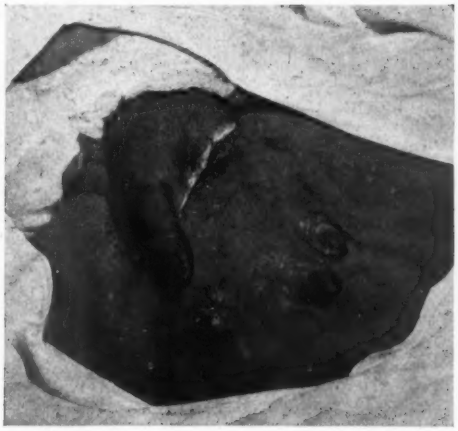

Fig. 13. *B*. Hand inserted into fat under skin.

difficult to deal with. At the wrist-joint in the severest cases, considerable destruction of the carpal bones may have occurred, ending in ankylosis of the joint, often in bizarre positions. It is not particularly common to find osteomyelitis except in the proximal interphalangeal joint and in the wrist-joint, but it may occur in the other bones.

The muscles have also undergone change. Those in the forearm have lost their tone and although active are impaired. The most unfortunate sequela, however, is that produced in the lumbrical and interosseous muscles. These are frequently entirely destroyed, due

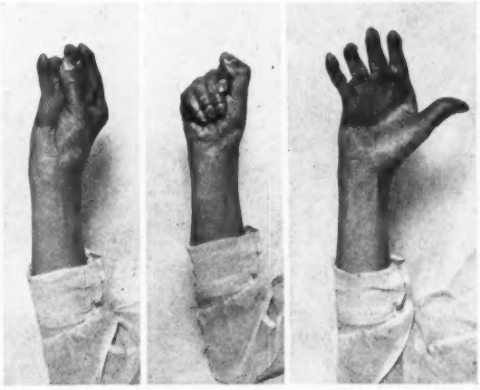

Fig. 13. *C*. Result 2 years after operation.

Fig. 14. Wesley Memorial Hospital No. 42,049. *A*. Crushing injury, slough of all skin on forearm, neglected ulnar and radial bursal infection. With loss of tendons and destruction of wrist-joint. Pictures show entire range of motion.

either to inflammation, destruction of innervation, or a lack of blood supply. The nerves have also partaken of the general devastation owing to the direct spread of the infection from the hand into the forearm along both the median and ulnar nerves. The nerves are surrounded by connective tissue and their vitality and function impaired. In the carpal canal it is frequently impossible without the greatest care to distinguish the nerves from the surrounding scar tissue of the tendons. If there has been pus in the middle palmar and thenar spaces, the digital

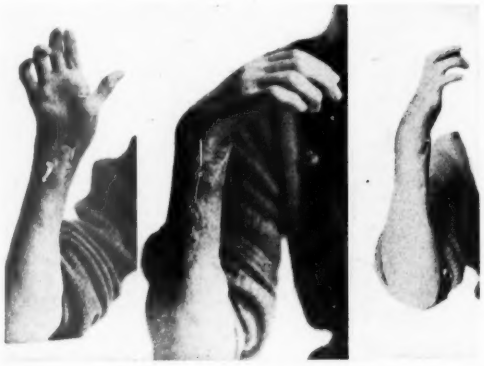

Fig. 14. *B*. Result one year after fat transplant and skin transplant.

branches of the nerves have also been pressed upon; the blood-vessels have suffered in the general connective-tissue contraction; the skin is glossy and shows the effect of a lack of both nerve and blood supply. The pathological picture, therefore, is one of destruction of nerve and blood supply with massive connective-tissue contraction about structures that have a most delicate function.

As to the clinical appearance, one sees a glossy skin with atrophied hypothenar, thenar, and forearm muscles and shrunken intermetacarpal spaces, the thumb frequently abducted and fixed, the fingers flexed upon themselves and extended on the hand, with fibrous ankylosis of the finger-joints, and

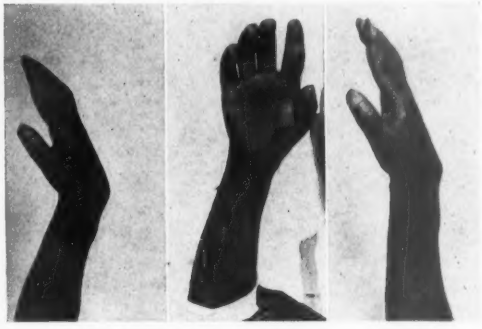

Fig. 15. Wesley Memorial Hospital No. 42,956. *A*. Neglected ulnar and radial bursal infection with destruction of tendons, etc., osteomyelitis of carpal bones with osseous ankylosis. Picture shows entire range of motion.

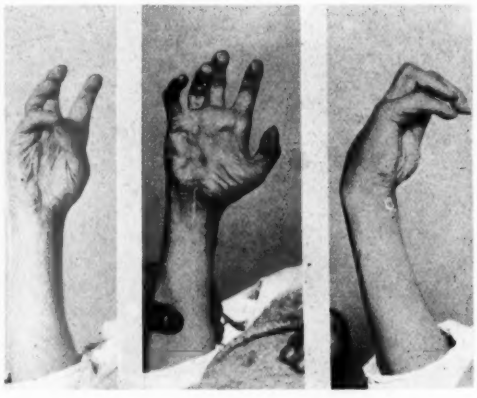

Fig. 15. *B*. Result 16 months after fat transplant.

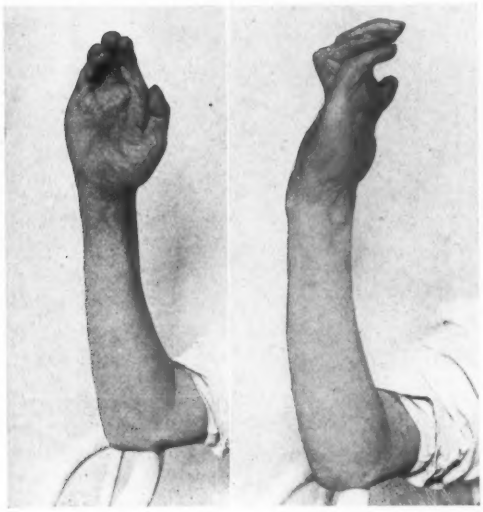

Fig. 16. Wesley Memorial Hospital No. 50,332. *A*. Osseous ankylosis of wrist-joint with atrophy and immobility following ulnar and radial bursal infection with extensions. Picture shows entire range of motion.

frequently osseous ankylosis at the wrist-joint producing an immobile, shrunken claw-hand, absolutely functionless and useless. Moreover, owing to the poor nerve and blood supply, the hand is often the seat of ulcers, frost-bites, and inadvertent burns. We have here drawn the picture of the worst type seen in these cases, that produced particularly by neglected ulnar and radial bursal infections in which the pus has been allowed to rupture into the forearm and frequently into the palm of the hand and the wrist-joint. Those cases in which the bursæ are opened promptly end frequently with contracture of the little finger but a fairly satisfactory result as far as function in the hand as a whole is concerned.

Patients presenting themselves have generally had their infections some months or years before and have tried all manner of massage without benefit. Indeed, in view of the pathological picture presented in these cases, it would be most remarkable if by such procedures one could produce any result.

For a number of years a study has been carried on in these cases with the hope that some surgical procedure might be developed

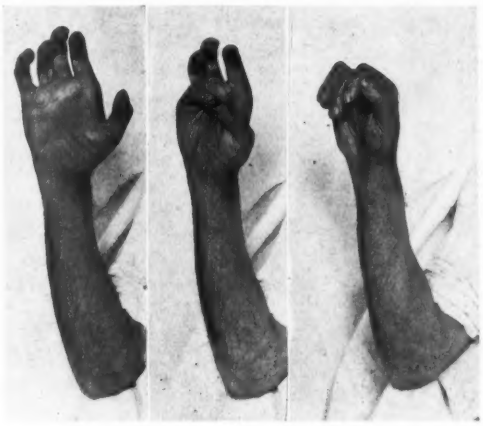

Fig. 16. *B*. Result two years after fat transplant.

that would offer relief to these sufferers. Owing to the fact that it takes a comparatively long time to obtain results and that not only must one correct the condition, but the muscle-tissue, nerves, and other structures must regenerate, it is difficult to determine what can be hoped for these cases. Moreover, owing to the fact that not much can be definitely promised, it has seemed wise to restrict any procedures, which must of necessity be more or less of an experimental nature, to those most serious cases in which no function was present and in which no hope could be offered that the hand would be better without some intervention. As a result of this study, however, it would seem justifiable to state that a considerable degree of function can be secured in a great majority of these otherwise hopeless cases, and in

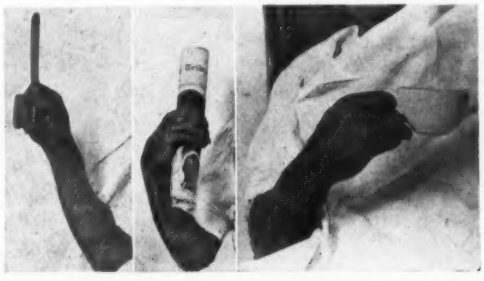

Fig. 16. *C*. Result two years after fat transplant.

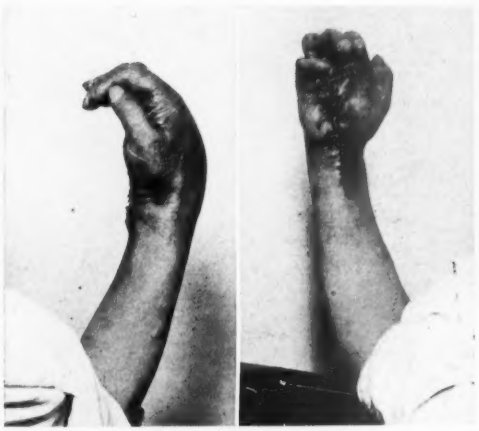

Fig. 17. Wesley Memorial Hospital. Photograph taken one week after transplant of fat for ulnar bursal infection with fibrous ankylosis of tendons.

Fig. 18. Photograph two years after fat transplant. Ulnar and radia bursal infection.

those less seriously involved where the patient has the time and the desire to persevere much more can be secured. If the operations are carefully performed, there will be a minimum of danger of impairing what little function may be present.

In those cases in which the infection has been upon the dorsum of the hand alone, incisions may be made to either side of the interwoven dorsal tendons, and a thin flap of fat inserted between the tendons and the bone and between the tendons and the skin. This flap of fat should not be too thick, since it would then be difficult to close the skin wound. If the technique is properly carried out, such adhesions can be almost entirely eradicated and a practically complete function restored.

Where we have midpalmar adhesions without an inflammation of the tendon sheaths a like good result can generally be promised. Here, however, the tendons, lumbrical muscles, the nerves, and the blood-vessels must be dissected out from the scar tissue with the greatest of patience, and flaps of fat from some other portion of the body transplanted both above and below the tendons. Especial care should be exercised to dissect out the lumbrical muscles. In fastening these flaps of fat about the muscles and about the nerves and blood-vessels, the finest obtainable catgut or silk is used and as few sutures as possible placed.

In those cases in which the tendon sheaths of the fingers have been the source of infection and in which but one finger has been involved, it would seem inadvisable in my experience to attempt any method of restoration. The loss of one finger does not incapacitate the patient and, moreover, in such cases, in which I have attempted to reconstruct or restore the tendon, the result has been such a grotesque finger that although some function has been secured, the patient would have been better satisfied without the finger than to have had the procedure carried out — and in this judgment I have concurred. If some thin membrane could be secured which could be wrapped around the tendon or through which the tendon could grow and still preserve the normal contour of the finger, we would even then have a contracture about the joint and in the joint which would seriously interfere with proper function. However, this is a result to be sought for.

It has been my experience to have several cases in which the patient had an ankylosis of the wrist-joint with or without inflammation of the tendons. In those cases in which the wrist-joint is ankylosed, without serious inflammation of the tendons, it has been possible to restore satisfactory function.

In the earlier cases it was my custom to remove but one row of the carpal bones, but later experience has taught me that it is wiser to remove the proximal and distal row and all the intervening tissue. Into this excavated

joint, pads of fat have been introduced taken from the abdomen or leg. It would seem to be inadvisable to overpack the joint, but on the other hand, it should not be underfilled. Some care must be exercised not to tear into the tendon sheaths in front if they have not been involved in a previous infection. It has been possible to remove the bones through a lateral dorsal incision at one side only. As soon as the wound is healed, the patient is allowed to use the hand as much as possible, and passive motion is begun, but no violent tearing is indulged in. These cases have been by far the most satisfactory that have come to me.

We now come to that type in which, while there has been a tenosynovitis in the little finger and thumb with the radial and ulnar bursæ involved, there has not developed an abscess in the palm of the hand, at least, not extensive enough to produce secondary adhesions, and there is consequently a moderate amount of function of the middle, index, and ring fingers. Every gradation of function may here be seen. If the condition has been treated early so much function is secured in these fingers that any operative procedure is inadvisable. The more serious types of these gradually shade into the most serious types of hand infection, presenting the contractions and adhesions I have described above and with which I have had the larger part of my experience. In these cases the patient must understand that at least two operations will be necessary and probably three or four before he can be discharged with a maximum amount of benefit. He must understand that he will be under treatment for a number of months, and he must also understand that the ultimate function to be obtained, while it may be fairly good, will never be as satisfactory as before the infection.

If ankylosis of the wrist-joint is present, it is my habit at the first operation to dissect out the tendons on the back of the hand, open the wrist-joint, and remove the bones, transplant fat into the joint about the tendons on the dorsum. The second operation, and by far the most difficult, is upon the flexor surface. A long incision is made over the ulnar half of the palm of the hand and onto the forearm. The anterior annular ligament is cut. The first endeavor should be to find the median and ulnar nerves in the forearm and trace them into the palm. In this step it is my custom to use magnifying spectacles for I have found that they are the only means by which I can surely identify the nerves in a mass of scar tissue. These nerves are dissected out of their surrounding tissues well down into the hand, the greatest care being used to avoid cutting any of the branches in the palm. This part of the procedure is of vital importance. Where blood-vessels are met, especial care is taken to preserve them.

The tendons as far as possible are dissected out of the mass of connective tissue. It is frequently necessary to use the connective tissue itself as tendons, dissecting strands which, although presenting no evidence of previous tendon function, will work satisfactorily. Where the tendons are completely destroyed and cannot be identified, and no connective tissue is left from which to make them, strands of silk can be inserted, but this contingency should be avoided if possible. The hook of the unciform may so interfere at times as to make its removal necessary if it has not been removed during a previous operation on the joint. The tendons are dissected down to the fingers and flaps of fat, split in three layers if possible, are inserted; one layer being under the tendons, one between the superficial and deep tendons, and one above. It is generally impossible to do this with as great attention to detail in protecting the individual digital nerves as one could hope. Here, again, an attempt should be made to preserve the lumbrical muscles if possible. The fat pad should extend well into the forearm. The wounds are then closed tightly. It is wise to draw attention to the necessity of the most scrupulous care in our technique, since such long and tedious dissection in tissue of low vitality is especially favorable to the development of infection.

As a final step in some, and as an individual step in other cases, a resection of both the ulna and the radius, with the removal of three or four centimeters, has aided materially in

producing satisfactory results. In some cases, however, this step will be of no benefit; therefore, it should not be resorted to without careful study.

It has been my experience to treat some cases in which there had been lacerated wounds of the hand and forearm with a severing of nerves or tendons, followed by infection with contracture of the hand as well as the forearm. Two of these cases have also suffered from extensive destruction of palmar fascia with infection. In these cases a transplant of skin as well as fatty tissue is applied. In the palmar case the hand was inserted into a pocket over the hip after the tendons had been dissected out. The result was not particularly satisfactory, however, until a subsequent operation in which I loosened the tendons again and transplanted them into the fat which still remained adherent to the transplanted flap. One error was made in this case in that the portion of skin chosen had considerable hair upon it, and, since the patient was a girl, it created some embarrassment, but after two or three years though the hair follicles still developed hair, it was of such a fine character as to be of no importance.

Another fact that has been impressed upon me, not alone by this case but by others of the same nature upon which I have transplanted skin, is that the subcutaneous fat which I had previously understood would be rapidly absorbed in the palmar flap, remained for a number of years. In one of the forearm cases, after the tendons and nerves were identified, sutured, and isolated from the connective-tissue mass, a transverse incision was made upon the abdomen with its convexity upward, and the skin edge of the everted flap was sutured to the ulnar side of the skin wound on the forearm. The subcutaneous fat was cut in sheets parallel to the skin but left attached at the base and wrapped about the tendons and nerves, the ends of the skin-flap being sutured to the caudal and cephalad ends of the forearm wound. At a subsequent period the skin was detached from the body and the cut edge sutured to the radial side of the wound. This patient had suffered a most serious infection and had in addition to the contracture of the hand, an ankylosis of the wrist-joint. Reproductions of photographs of this patient are herewith presented. The result, while not anatomically perfect and one which I believe that now with my added experience could be improved, is most satisfactory to the patient since he is able to feed himself and use his hand in eating, working, and in all the gross functions required.

CONCLUSIONS

Out of the thirty-two cases here reported secondary infection with loss of the fat did not occur except in four cases, viz., the breast cases, and here the result was probably due to the nature of the operation and the large field and the osteomyelitis cases. Therefore, it would seem safe to say that fat can be transplanted into any ordinary field with the assurance that it will not act as a foreign body. Clinically, it would appear to live and become a part of the structure in which it is placed. It surely persists for many months and probably years.

Fat may be transplanted into small infected areas with some degree of success as is shown by the two cases reported. The fat should not be packed too tightly into the field in which it is placed.

The author's results would seem to indicate that the greatest value of fat transplantation is to be found in its use in plastic operations to restore mobility and remove disfigurement, as a protection to prevent contracture about vessels and nerves, and to prevent adhesions about tendons and joints. Its use in tuberculous joints and bones is still a fruitful field of study, and the same may be said of its use in traumatic epilepsy, although it can be used safely to obliterate defects in brain tissue. In the author's hands the use of fat transplants in large, open potentially infective areas, such as are present after breast amputations, etc., and in osteomyelitis, has not been satisfactory.

THE PERIPENIC MUSCLE; SOME OBSERVATIONS ON THE ANATOMY OF PHIMOSIS

By GEOFFREY JEFFERSON, M.S., Lond., F.R.C.S., (Eng.), Victoria, B. C.

MY attention having been called to the peripenic muscle by an experience during an operation, an investigation was undertaken the results of which are appended below.

It is not very generally realized that the dartos muscle of the scrotum is continued forward beneath the skin of the penis to form the peripenic muscle (Fig. 1). This muscle sheet has a certain practical importance, for by the agency of its fibers the distal opening of the prepuce is liable to marked alterations, seeming larger at some times than at others, according to the state of contraction of this subcutaneous muscle.

The peripenic muscle appears accurately to have been described for the first time by Sappey (1) in 1860, but it is passed over with the briefest mention by the majority of anatomical textbooks. It will be remembered that the superficial fascia of the bodies of many of the lower animals contains a thin muscle sheet, the panniculus carnosus. In man the dartos, the fasciæ of Colles and Scarpa, and the platysma myoides, are the only remnants of this once widely distributed muscle layer. It has been thought that the dartos extends into the penis only for a short distance on its under side, in the so-called area scroti of Klatsch. These are two areas, one on either side of the root of the penis on its under surface, differing from the rest of the penic skin in presenting a darker, rougher appearance, in being very rich in sebaceous glands, and plentifully provided with hairs (6). This is too conservative an estimate of the extent of the muscle-tissue, for my own observations agree with the excellent account given by Delbet (2) that the muscle extends over the whole length of the penis.

MATERIAL

I have examined a series of ten prepuces removed at operation (circumcision), the ages of the patients ranging from a few weeks to thirty years. The whole length of the penis was examined in one specimen only, a twin fœtus of 30 weeks, in which the whole penis and scrotum were of convenient size for cutting *en bloc*. I can, therefore speak with more authority on the preputial part of the peripenic muscle than upon the remainder, the former portion being surgically the more important. The specimens were embedded in paraffin and the sections stained with Ehrlich's acid hæmatoxylin, Van Gieson's picrosaurefuchsin being employed as a differential stain for smooth muscle. The amount of muscle-tissue present beneath the skin is really rather astonishing.

THE PERIPENIC MUSCLE

Like the scrotal dartos, of which it is a direct prolongation, the peripenic muscle is composed of unstriped fibers which form an incomplete investment of the penis from its base to the extremity of the prepuce. The muscle is situated 1 or 2 mm. beneath the skin, from which it is quite separate except inferiorly in the region of the median raphe. In the many sections examined by me the muscle fibers were plentiful. Owing to their great diversity of direction only a few fibers can be seen running the same way in any one microscopic field (Fig. 4). The muscle-bundles are very slender and are made up of a few muscle-cells only, but they run in every direction transversely, longitudinally, and obliquely. In the prepuce a great many of the fibers course in the long axis of the organ. The fibers are loosely packed (Fig. 2), the intervals between the muscle-bundles being filled up with lax fibrous tissue. There is of course no subcutaneous fat in the penis. The muscle forms a sheet of practically equal thickness in its whole extent, but owing to the doubling of the skin to form the prepuce the muscle-fibers are rather more abundant in that region, as the muscle lines, to a certain extent, the inner "mucosal" layer of the pre-

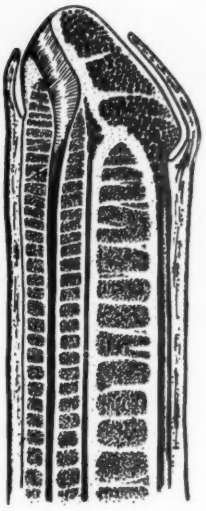

Fig. 1. Diagram of the penis to show the general disposition of the peripenic muscle.

Fig. 2. x 120. Longitudinal section of prepuce, male, aged 25. Subcutaneous portion only. Several smooth-muscle fibers can be seen. Some are cut longitudinally, some obliquely, and others transversely, thus demonstrating the diverse directions in which the bands of muscle run.

puce as well as the outer. Woolsey (5) remarks that the dartos fibers at the end of the prepuce are circularly arranged, forming a kind of sphincter. There was no special collection of fibers such as might be thought to indicate a sphincter in any of the specimens which I examined, but the sphincteric possibilities of any part of the preputial portion of the muscle cannot be denied.

The development and strength of the whole dartos sheet varies greatly in different individuals, and the peripenic muscle is not always well formed. It is particularly likely to be weak in persons with dependent, lax, smooth scrotums. The muscle was present in all the ten prepuces examined; it was poorly developed in one case only. Charpy reports that he has seen it absent in its preputial portion. The peripenic muscle is doubtless the cause of the marked rugosity usually exhibited by the removed prepuce or the prepuce under the stimulus of cold. These rugæ are in the main arranged transversely, but innumerable minute vertical ridges are superposed upon these. There can be no doubt but that the purpose of the muscle is to adapt the skin to the varying volume of the organ, as the changes are greater than could be accommodated by the elasticity of the skin alone. It has been suggested that the muscle may aid in erection by compression of the dorsal vein, but this influence could hardly be exerted to any great extent upon the vena dorsalis penis profunda (which drains the erectile tissue), as this vein is protected by the fascia propria penis, though the superficial vessel might be constricted.

The prepuces of the lower animals are usually more complicated than man's (see for instance the horse and ox, 4, which have a double prepuce, the outer, at least, very muscular), so homologies are difficult to establish.

THE PERIPENIC MUSCLE AND PHIMOSIS

As has already been said, under the stimulus of cold the peripenic muscle contracts just as does the scrotal dartos, and whereas the contraction of the latter draws the testes close to the body, contraction of the former causes the skin to conform to the reduced size of the organ, and the prepuce, if of any length, to shrivel into a small knot beyond the glans. If the prepuce is short it tends to retract behind the glans and the muscular contraction makes it very difficult to draw the fold of skin forward. It will be realized that this muscle has considerable potentialities in the question of phimosis and possibly also in paraphimosis. It is common to observe

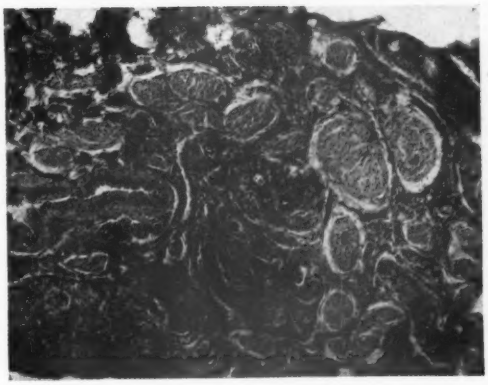

Fig. 3. x 100. Transverse section, prepuce of male aged 17. The bundles of the peripenic muscle are readily seen.

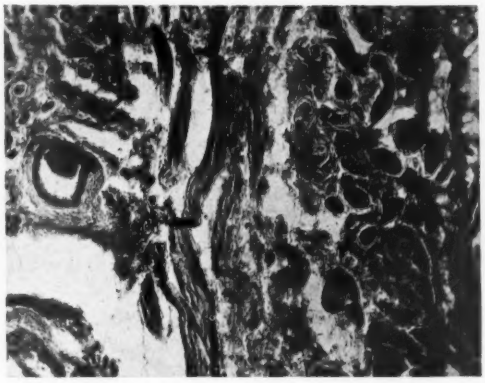

Fig. 4. x 120. Longitudinal section, prepuce of male aged 17. The peripenic muscle fibers run across the middle of the field; others are cut transversely.

how different an appearance many phimosis cases present if seen on different occasions under different conditions. It may at one time be impossible to retract the skin enough to get a glimpse of the glans, while at other times the preputial orifice may be several millimeters in diameter. This change is brought about by muscular activity and the possibility of such contraction should be borne in mind when an opinion is to be given as to the desirability of circumcision. As is characteristic of smooth muscle everywhere, the peripenic muscle contracts very slowly and sluggishly, so that the alterations which it induces are slow to occur and, being slight, are usually overlooked.

Surgical textbooks sometimes describe two varieties of phimosis, namely the hypertrophic and the atrophic, these besides the ordinary classes of congenital and acquired. The distinction between the two forms lies in the amount of prepuce present, difficulty or impossibility of retraction of the foreskin being common to both varieties (3). Thus, in the hypertrophic form the prepuce is abundant but has too small a distal opening, while in the atrophic form the prepuce is short as well as too narrow (see Fig. 6). This distinction is, in the adult, artificial to a certain extent, as the two varieties can be seen on the same patient under different circumstances. For the peripenic muscle not only can alter the size of the preputial opening but, aided perhaps by a certain shrinkage of the penis, can cause the prepuce to appear redundant, while at other times it is barely sufficient to cover the glans (Fig. 6). This statement cannot be so rigidly applied to infants, in whom redundancy of the foreskin is common. The probabilities are that such redundancy is not only common but normal; the skin awaits the development of the corpora cavernosa and spongiosum which will occur at puberty.

The writer might have doubted the latent powers of this muscle had he not met with a remarkable example.

A male, aged 35, suffered from a phimosis; the prepuce was just long enough to cover the glans, but the opening was too small for retraction. Circumcision was advised. Under the influence of the alcoholic solution of iodine with which the penis was painted beforehand the peripenic muscle underwent a very powerful tonic contraction. The tip of the prepuce became somewhat inverted and the muscular contraction was of so determined a character that it was impossible to roll the prepuce backward to display its distal opening. This rendered an accurate estimation of the amount of skin to be removed extremely difficult, and too much was very nearly removed. When the section was made the muscle slowly relaxed.

A colleague had an experience which helps to emphasize the powers of the muscle: On one occasion he found it impossible to introduce in the cold a catheter through the preputial orifice of an adult male who had a phimosis, while the meatus

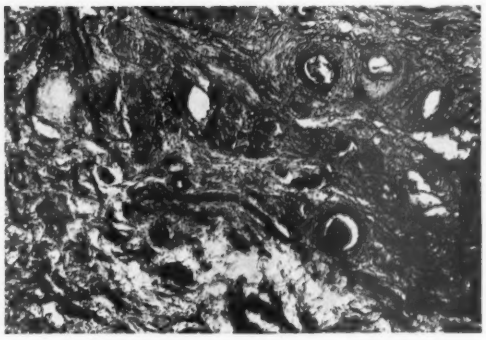

Fig. 5. Prepuce of an infant. Several bands of muscle tissue can be seen in this field, running in different directions.

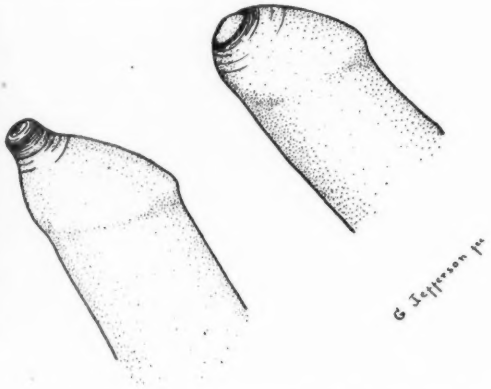

Fig. 6. The so-called hypertrophic (left) and atrophic (right) varieties of phimosis. The peripenic muscle is often capable of converting the one into the other. The circular terminal preputial fibers alone are indicated in red in this figure; the muscle fibers run in all directions (see text).

and tip of the glans could be easily displayed in the warmth of the operating room (Fig. 6).

Experiences such as these illustrate the vigor of the peripenic muscle under favorable circumstances, and induce one to take more heed of its possibilities.

It is probable that far more circumcisions are performed upon infants than are really necessary. It is not widely enough realized, particularly by the lay public, that a condition of phimosis is normal at birth. It is inconceivable that children are born with actual deformities in this region as often as the statistics of circumcision would lead an observer to suppose. It is not until the penis undergoes its final development at puberty that the proper balance between the prepuce and glans is struck. Further, adhesion between the prepuce and glans is not an absolute abnormality, nor one which time cannot correct. This point merits, perhaps, some discussion.

THE NATURE OF THE ADHESION BETWEEN THE GLANS PENIS AND PREPUCE ENCOUNTERED AT CIRCUMCISION.

All operators must have been struck by the great tenacity of the adhesion between the glans and the prepuce. However careful a dissection is made raw surfaces are commonly left on the glans, and sometimes these are of considerable extent, detracting from an otherwise æsthetically perfect result. As a rule, the younger the child the worse the glans looks. These abrasions usually heal easily without leaving permanent scarring, but it would be well if they could be avoided. That these abrasions are inevitable is readily seen on reference to the photomicrograph of the corona glandis of a 30 week fœtus. It will be seen (Fig. 7) that the corona and balanopreputial space are filled up with epithelial cells which bind the inner surface of the prepuce to the glans. These cells form the "adhesion" which is so difficult to break down without injury to the superficial cells of the glans and prepuce. The origin of these cells is best explained by the more recent accounts of the development of the prepuce. It was formerly believed that the tip of the genital tubercle represented the glans penis or clitoridis, and that the prepuce grew forward over this from the outer genital folds (7). Berry Hart (8) and Wood Jones (9) have independently shown that the genital tubercle is a skin-covered papilla and that the glans is sculptured out (to use Wood Jones' phrase) within the solid tubercle by the invasion of a mass of epithelial cells which start from the site of the future preputial orifice. The invading cells burrow not only circumferentially but centrally, the latter advancing as a solid plug into the tip of the glans. The breaking down of the for-

mer leads to the liberation of the prepuce, the degeneration of the latter forms the terminal portion of the urethra. The breaking down of the preputial cells begins late in fœtal life and is commonly incomplete at birth, making retraction of the prepuce impossible even though the preputial orifice itself is large. Failure of these cells to desquamate is sometimes though rarely met with in the female. In such cases the prepuce entirely covers the glans clitoridis.

It will be noted that there is no evidence of any glands in the corona such as Tyson described in the orang-outang. Opinion that these glands do not exist is growing; Sprunk examined 300 human penes without finding a single gland of Tyson (1). There are a few rudimentary sebaceous glands in the inner layer of the prepuce. This last is nothing more than a slightly modified skin, possessing few layers of cells, very few primitive sebaceous glands and no hairs (Fig. 7). In youth the so-called mucous membrane of the prepuce and glans is certainly far different from that of the mouth or vagina, but probably becomes more deeply stratified if the glans becomes largely uncovered (as it often does) at puberty.

SUMMARY

An examination of ten prepuces removed at circumcision and one entire penis and scrotum (fœtal) confirms the existence of abundant unstriped muscle-fiber beneath the skin of the penis. These are prolongations of the dartos sheet and form the "peripenic muscle." The fibers of this muscle possess the power of altering the preputial orifice to a certain extent, and hence a consideration of the latent powers of the muscle in causing varying degrees of phimosis is important.

Fig. 7. Longitudinal section, penis of fetus of 30 weeks. Note the cells filling up the balano-preputial space and binding the glans to the prepuce. Note absence of Tyson's glands at corona. Urethra not shown.

The writer wishes to thank his colleagues at St. Joseph's Hospital, and also Dr. W. E. Home, pathologist to the Provincial Royal Jubilee Hospital, for several of the specimens examined.

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GAS-BACILLUS INFECTION; SURGICAL BACTERIOLOGY[1]

By JOSEPH COLT BLOODGOOD, M.D., F.A.C.S., Baltimore

THE successful development of aseptic surgery has apparently influenced surgeons and bacteriologists to discontinue their interest in and investigations of bacteriological problems. There is hardly a surgical clinic in this country today with an active and well developed bacteriological department. There are few, if any, trained surgical bacteriologists in this country. We have apparently lost interest in infected wounds and in the bacteriology of infectious diseases. In civil practice the majority of wounds are aseptic. Accidental wounds reach the hospital so quickly that grave infections rarely take place.

Before the present war it was the general opinion among military surgeons that the immediate treatment of bullet wounds with iodine and the application of a first-aid dressing would insure the healing of the wound. Surgeons with splendid training in asepsis and of great operative experience and skill in the common operations of civil life found themselves absolutely unprepared for the huge and practically always infected shell wounds of the present war. We are told that first-aid measures have failed, antiseptics are of no value.

The surgery of infected wounds had been thoroughly established before this war and had practically reached its limits.

The free opening of the infected wound, the removal of foreign bodies, the establishment of perfect drainage, the frequent irrigations and the continuous-bath treatment were methods worked out more than a quarter of a century ago, and even longer. Apparently many of the younger aseptic surgeons were not familiar with these older well-established surgical procedures, and those who knew of them found that their inexperience interfered with the development of what we may call surgical judgment which allows the surgeon to decide as to the best time and means for performing this established surgical procedure to obtain the best results. The most experienced surgeons at the front today emphasize the importance of this necessary surgical qualification — judgment. However, when this judgment is developed to its highest degree and when all the possibilities of surgical intervention have been exhausted, there is still left an infected wound and usually a general infection.

The surgical world was therefore absolutely unprepared to meet the unexpected avalanche of infected shell wounds with and without compound fracture.

In the past, then, we had developed surgical bacteriology only so far as to meet the urgent and most frequent demands of the day. We had not used our imagination as to what might happen in the future and as to what new demands might be thrown upon surgery.

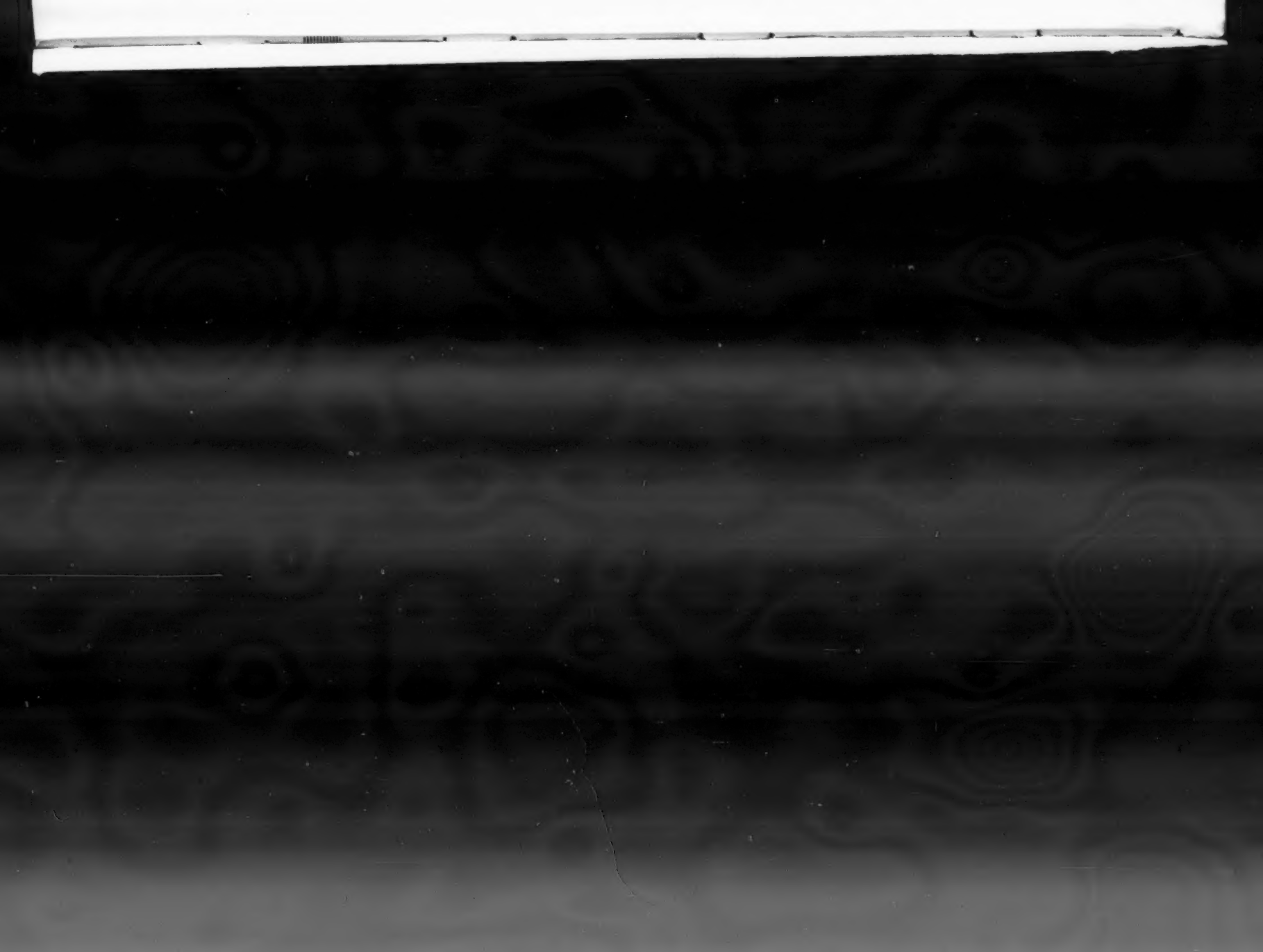
The introduction of carbolic acid by Lister was entirely dependent upon the bacteriological work of Pasteur. The full development of aseptic surgery progressed step by step along with the development of surgical bacteriology. The sterilization of everything that came in contact with the wound was due to the science of bacteriology. The inability to thoroughly cleanse the hands and the introduction of rubber gloves was due to the surgeon's interest in the important problems of the day, that is, to make a wound, close it, and have it heal per primam. This is chiefly the work of civil surgeons.

When aspetic or clean surgery was developed interest in bacteriology ceased. Our clean wounds healed. Why investigate further? Infected wounds and infections were rare, so uncommon that practically no further investigation was made along this line.

Welch and Nuttall[2] discovered the gas bacillus at an autopsy in 1892. From then on bacteriologists were intensely interested in cultivating the gas bacillus, the surgeon in recognizing the infection and performing the proper operation immediately. But in all the succeeding years the interest in this gas-

[1] Read before the American Surgical Association, Washington, May, 1916.

[2] Johns Hopkins Hosp. Bull., 1892, vol. iii, July-August.



bacillus infection apparently did not go beyond the problem of the demonstration of the organism in the wound or the surgical problem of incision, drainage, bath treatment, or when to amputate to save the patient's life. There was no investigation along scientific lines, or in the laboratory, as to the possibility of some specific antiseptic for this infection (chemotherapy), or the production of a curative or protective serum.

If we had today for the gas bacillus a protective serum as efficacious as those for tetanus and typhoid, wounds in this war would be a different problem.

The results of the tetanus antitoxin as a protective serum are confirmed by the experience in this war. However, when tetanus is treated after the clinical picture is well established, we have apparently made little progress in treatment. At least, there is a tremendous difference of opinion as to the real efficacy of the various forms of treatment.

The same is true of practically all surgical infections, except syphilis and tuberculosis. The Wassermann test and the chemotherapeutic agent, salvarsan, have given a method of recognition and control of this surgical infection far beyond any other.

In the syphilitic inflammation, whatever its type, there is a local growth of new tissue associated with necrosis. Yet, even after the older treatment, but more especially after salvarsan, this diseased tissue disappears and is replaced by normal tissue, that is, restoration to normal is almost perfectly accomplished, except in the tissues of the nervous system.

These results of Wassermann and Ehrlich should give rise to hope and should stimulate other investigators to make similar attempts for other surgical infections.

The marvelous effects of diphtheria antitoxin also suggest similar possibilities for other infections. We need more men of the type of Pasteur, Koch and Ehrlich. Investigations of this kind must be done in the best-equipped laboratories and require large financial support.

It is quite true that Wright's investigations on surgical infections with the development of the opsonic index and vaccines, created tremendous interest, but apparently the consensus of opinion is that the vaccine treatment for infections has failed.

The improvement in the treatment of surgical tuberculosis is apparently due neither to a chemotherapeutic agent nor to a serum, but to the early recognition of the disease, the better knowledge of certain portals of entrance, and the larger expert experience in the details of general hygienic treatment.

In the beginning we were especially interested in the bacteriology of appendicular abscess and peritonitis, but we soon found that best results were obtained by the early clinical diagnosis followed by an operation before abscess or peritonitis developed, and since then we have lost interest in cases of peritonitis which fortunately are growing fewer and fewer. But at the present time we have no new method of attack when we are unfortunately called on to treat peritonitis in the late stage. Undoubtedly many lives could be saved if we had developed by continuous and intensive investigation some serum or chemotherapeutic agent against the well-known bacteria of general peritonitis.

In the beginning cultures were always taken from the gall-bladder and from within gallstones, but as the results of operation upon the gall-bladder and ducts became so uniformly good, we lost interest in the smaller group of severe cholangitis in spite of the fact that our well-developed surgical procedures, successful in the majority of cases, failed here.

Surgeons are apparently almost powerless in the combat against all general infections and types of infection like erysipelas and thrombophlebitis.

Even the successful surgical therapy of local infection is by no means satisfactory. Large incisions and free drainage lead to fixed tendons, ankylosed joints, scar contraction and peritoneal adhesions. To cure an infection by amputation cannot be looked upon as a great triumph.

It seems strange that after the splendid achievements of aseptic surgery, the development of anæsthesia, the low operative mortality, and the great improvement of

ultimate results, no surgeon or great surgical clinic could take interest in the smaller group. Because all of these infections were occurring in civil practice, and the disastrous results of either death or mutilation were well known.

Even a careful reading of the literature of the Russo-Japanese war, or of the Balkan wars, or the Boer war, would have allowed one to foretell what would happen in a greater war in which artillery predominated over rifles and trenches over open fields.

Von Reyher from his experience in the Russo-Japanese war advocated the immediate opening of all wounds in the region of the buttocks, because of his observation that gas-bacillus infection with emphysema usually developed. Why, therefore, wait for the clinical manifestations?

In some surgical clinics in this country the chief minds are devoting their attention largely to experimental surgery, of a physiological or technical character, others to pathological problems; but as yet we have no well-rounded surgical clinic.

The day has passed when any one surgeon can be expert in everything. The time has come for the large surgical clinics to encourage the development of one or more men in the different departments, and there should be something more than an orthopedic, genito-urinary, gynecological, oral, gastro-enterological, and tumor departments. Some surgeons should develop bacteriology, others pathology, still others physiological problems, and there is no reason why some skilled operating surgeon should not investigate the chemical problems of surgical diseases; for example, much has been done in the study of the chemistry of the thyroid, while practically nothing has been done in the chemistry of malignant tumors.

All large surgical clinics, especially those connected with universities, should begin at once to stimulate the younger men to take up one of these lines of investigation on their entrance into the clinic. Twenty-five years ago a physician in Philadelphia defined a surgeon as a man who worked with his hands, and an internist as one who worked with his mind. I am confident that this day has passed.

There is sufficient evidence to show that the surgeon can acquire and maintain skill in operative technique and still have ample time to investigate and develop along any one of the above lines.

The surgeon should not only be his own diagnostician as well as his own operator, but also his own investigator, and the different large clinics of this country should attempt to have in their groups men working and investigating along these different lines.

The surgeons must investigate their own problems.

The internist and all the departments of clinical medicine have their own problems and they must also develop along similar lines. This will by no means interfere with the prerogative of the departments of pathology, bacteriology, chemistry, or physiology.

It is my opinion that we have sent to Europe too many men interested in and trained for operative work only, and too few specially fitted for investigating the great problems of surgical infection.

Although the first title of this paper is "Gas-Bacillus Infection" I found after going over my personal experience[1] which began in 1895, and the literature which I have read carefully since, that the larger problems of surgical bacteriology could not be forced in the background, and in addition, in spite of this long and large experience, and in spite of most careful study of the literature, I found that I had nothing new to offer that was not well known to all of you, or easily accessible in the literature of the present war.

[1] Progressive Medicine, 1899, December, p. 159.

THE BEGINNINGS OF THE BIRTH-CONTROL MOVEMENT[1]

By Professor JAMES A. FIELD, Chicago
University of Chicago

MY part in this program is to sketch a historical background for the papers and the discussion which are to follow, in so far as they deal with the movement for birth-control, so-called. I do not, for a moment, mean to imply that this fragment of history accounts for the whole fact of birth-control as it is at present practiced; because the prevention of conception has, I suppose, been practiced in one way or another, sporadically or by custom, among pretty much all peoples of antiquity and of more recent times. But the birth-control propaganda that we hear about has a fairly definite history of a hundred years; and it is that particular history I have been asked to say something about.

It is ordinarily believed, by those who have given attention to this propaganda, that it had its origin in England in the decade of the seventies, or, to be more exact, in 1877. It is true that there was just then an outburst of agitation so much more effective than any that had preceded it that in a sense it was the beginning of the movement of the present day. But in strictness there was at that time not so much new thought as new publicity and a new degree of organized activity in making known the arguments for birth-control by the prevention of conception.

To understand the story we must go back to Malthus and his *Essay on the Principle of Population*, first written in 1798. The central principle of that Malthusian essay was, as you know, that human beings, like all other living beings, are cursed with a power of reproduction quite out of proportion to their power to maintain all the individuals who may be born. At first Malthus contended that this tendency to excessive increase resulted inevitably in either misery or vice. In later editions of his book he so far modified his original position as to recognize a possible escape from this dilemma through the exercise of "moral restraint"; that is, through postponement of marriage and of all sexual relations whatsoever until a man saw himself in an assured way to support whatever family he might have. It was substantially in this form that Malthus left his analysis. Pressure of population brings into the world indefinite wretchedness and suffering, which can morally be avoided only by deferring marriage so long that smaller families result. Whether or not this suggestion of moral restraint offers a solution of the population problem depends upon whether or not the mass of mankind can be relied upon for such austere and sustained self-control. There were many among the contemporaries of Malthus who felt that for all practical purposes he left the picture as black as he had originally painted it.

Malthus was associated with the utilitarian thinkers of his time; but when it came to questions of sex morality he abandoned his utilitarianism and clung to the traditional code. Improvident marriages he sternly condemned; yet he refused to discuss or even to countenance the proposal that once persons were married the size of their families should be made subject to deliberate control. Hence to the out-and-out utilitarians it seemed that he had stopped short in the middle of his argument. He had demonstrated that overpopulation was the main source of suffering and vice, but he had shrunk from the conclusion that such a vast evil might justify resort to distasteful remedies. It remained for his more consistently radical contemporaries to push on where he had paused; to seek the ideal of the greatest good by the expedient of the lesser evil; and to take the stand that in consequence of Malthus' own statement of the population problem it had become the positive moral duty of the married as well as of the unmarried not to give existence to beings for whom they could not properly provide.

Among the distinguished utilitarians whom Malthus' reasoning led to this position may be mentioned probably Jeremy Bentham

[1] The substance of remarks before the joint session of the Chicago Gynecological Society and the Chicago Medical Society, February 16, 1916.
(For discussion see p. 234.)

himself, and certainly James Mill, John Stuart Mill, and Grote, the historian. More important, however, in the history of the Neo-Malthusian birth-control movement, is Francis Place, a picturesque and vigorous personage who rose from degraded poverty to the station of a prosperous master-tailor, and whose wide reading and remarkable judgment of political and social conditions made him the friend of some of the most intellectual men of his day and a powerful organizer of reforms. Place sprang from the London working class, and with that class his sympathies always remained. The population problem had been presented to him directly and intimately. He virtually owed his whole moral salvation to a very youthful marriage; but this same marriage had burdened him with fourteen or fifteen children and filled his early years with the harshest poverty. He knew by experience what overpopulation meant; but he was profoundly convinced that to have remained unmarried would have meant his moral ruin. Hence he concluded that the only solution of the poor man's population problem was early marriage and limitation of family. This view he set forth frankly in a book, *Illustrations and Proofs of the Principle of Population*, which he published in 1822.

In the following year a group of radicals of whom Place was very probably the leader began to distribute in the industrial districts of London and Lancashire leaflets designed to acquaint the working classes with means of preventing conception. These, the so-called "diabolical handbills," were the cause of first an outcry and then a more serious discussion. They attained, apparently, a considerable circulation; and they were instrumental in bringing forth a more substantial pamphlet literature, of which Richard Carlile's *Every Woman's Book* and Robert Dale Owen's *Moral Physiology* may be mentioned as the most important items. These two tracts attempted to deal with the physiological facts of reproduction as well as with the economics of overpopulation; and very naturally they prepared the way for the entrance of physicians into the Neo-Malthusian discussion.

The first noteworthy contribution from a medical man was the pamphlet entitled *Fruits of Philosophy*, written in this country by Dr. Charles Knowlton, of Massachusetts, and published in 1833. Dr. Knowlton appears to have been not only an eccentric, but a sexual hypochondriac, whom years of worry and depression had led to take an interest in the general question of sex. When he learned of the Neo-Malthusian arguments and read Robert Dale Owen's statement of the case for birth-control instead of sexual repression, he was led to put forth his own views, and in particular to devote a chapter to the prevention of conception. His book was reprinted in England and for forty years was more or less known to working-class radicals and free-thinkers. Then, in 1876, it furnished the ground for a prosecution which gave it a great though accidental notoriety.

Meantime another and intrinsically more remarkable book had appeared. This work, later called *The Elements of Social Science*, had at first the more striking title, *Physical, Sexual and Natural Religion*. The anonymous author, Dr. George Drysdale, was a physician of high intellectual ability; and his book, radical and even fantastic as it was, was none the less in its way a brilliant performance for a student hardly out of his medical school training. The book, first published in 1854, strove to show that the physical functions of man are of equal importance and dignity with the mental functions, and equally worthy of cultivation and exercise. To this rule the sexual function was held to be certainly no exception. Accordingly Dr. Drysdale ventured to revolutionize the code of sexual ethics. Recognizing, as did Dr. Knowlton, the kinship between some of his doctrines and those of the Neo-Malthusians, Dr. Drysdale turned his attention more and more to Malthus and the economic explanation of poverty through overpopulation. *The Elements of Social Science*, in its elaborated form, was a literary crusade against what its author regarded as the three great and interrelated evils of poverty, prostitution, and celibacy. Only by the prevention of conception could society escape all three evils.

In 1876 a bookseller of Bristol, England, who had been selling indecently illustrated copies of Dr. Knowlton's *Fruits of Philosophy*, was arrested, tried, and convicted of selling an obscene book. The authorities turned their attention next to the publisher of the pamphlet, whom they persuaded to repudiate the work. This publisher was at that time the publisher also of much of the tract literature of the English secularists. His recantation seemed to some of the free-thinkers equivalent to an abandonment of the right of free discussion; and accordingly the leaders of the free-thought movement, Charles Bradlaugh and Mrs. Annie Besant, wishing to test the right of publication, deliberately brought out a new edition of the Knowlton pamphlet, in 1877, and challenged the police to arrest them. They were presently arraigned and brought to trial in the Court of Queen's Bench, before the Lord Chief Justice and a special jury. The Solicitor-General appeared against them: Bradlaugh and Mrs. Besant conducted their own able and dramatic defense. The case attracted inordinate attention; and by the time it had led to a half-hearted verdict of guilty, which was subsequently set aside on technical grounds, both judge and prosecutor were agreed that the trial had accomplished just what the prosecution had desired to prevent. The plea for Neo-Malthusianism had been proclaimed to all England; and, if Mrs. Besant's figures may be taken as correct, three months' sales of *Fruits of Philosophy* had disposed of as many copies as would at the old rate have lasted for eighty years.

The Bradlaugh-Besant trial brought into prominence the Malthusian League. This organization, which owed its origin to Bradlaugh and Dr. George Drysdale, and which had nominally existed for over fifteen years, was now revived, and, under the presidency of Dr. Charles R. Drysdale, brother of Dr. George Drysdale, became influential in organizing and diffusing Neo-Malthusian opinion not only in England but in some of the countries of continental Europe. The Dutch society of similar name which has done so much to further the birth-control movement in Holland was suggested by the English league. In many other countries the example has been followed.

Organized or unorganized, the movement is becoming practically world-wide. One cannot of course contend that the notoriety of the Bradlaugh-Besant trial, or of similar trials elsewhere, is the primary cause of our present-day falling birth-rate. No doubt deep-lying influences more or less inherent in modern social conditions have led civilized peoples to extend their power of control over nature until they now exert a voluntary control over human propagation itself. But one can hardly venture to deny that the agitation of the seventies must have done much to hasten the effects of these social and economic motives. It is, to say the least, a very striking coincidence that the English birth-rate began so abruptly to fall about 1878; that the vigorous increase of population in New South Wales slackened simultaneously with the circulation and legal vindication there of Neo-Malthusian leaflets; or that the decade of the eighties was marked by an unmistakable decline of the birth-rate in virtually every country where reliable records were kept.

Two general facts stand out prominently in this brief chapter of history. First, the more the movement for birth-control has been opposed, the more it has flourished. Attempts to suppress it have again and again given it fresh notoriety, and have aroused its partisans to new enthusiasm. One community after another has tried prosecution and concluded to drop it. Our own federal authorities appear to be the latest to learn discretion from the irony of this experience.

The second point seems to me more particularly to concern an audience like this. The champions of Neo-Malthusianism, one after another, have been treated by the mass of the community as intellectual and moral outlaws. They have of course been radicals always, and often they have been in revolt against established religion and the existing government as well as against traditional sex-morality. In a sense this fact seems to discredit the propaganda of birth-control by making it appear as the whim of immoderate and unbalanced minds. Undeniably some of

the propagandists have gone to outrageous lengths in their zeal. But it may fairly be contended that the blame for such excess of radicalism lies in good part at the door of the smug conservatives who have refused to recognize the sincerity of the Neo-Malthusians and have denied them fair hearing. At any rate, the whole birth-control program remains clouded in ignorance and prejudice.

The history of the movement, the portentous significance of birth-control, no longer as a possibility only but as an accomplished fact, demand our most discerning scientific attention. The practical question now is not whether the prevention of conception shall be tolerated—it is already tolerated and approved by great numbers of persons—but under what circumstances it is to be tolerated: in what forms, for what purposes, to what extent, and so on. Our effort should be not to keep it outside the moral pale, but to find a place for it among our civilizing discoveries; for since mankind has acquired rational mastery of its own reproduction it will hardly forget or abandon its knowledge and power. Time will test this prediction. In the meantime there is an almost unlimited opportunity to bring to bear upon these questions the dignified and intelligent discussion which physicians in good standing can bring.

SOME PRACTICAL ASPECTS OF BIRTH-CONTROL[1]

By RACHELLE S. YARROS, M.D., Chicago

WHILE Mr. Field briefly sketches the history of the movement and Dr. Hamilton tells you something about the present status of the birth-control movement abroad, I shall speak of some of its phases in this country, from the standpoint of a practicing physician and one deeply interested in social work. As I understand the present movement it is aiming to obtain freedom in matters of birth-control—that is, that people should not only be allowed but encouraged to obtain knowledge which will help to make birth-control a fact; consequently, all legal obstacles in the way of education in the prevention of conception should be removed. It is a mistake to think that the mere removal of such legislation would serve our social needs. It is necessary in addition to that to undertake an active educational campaign among the largest class of our population in order to remove the religious, so-called moral, and old-fashioned medical reasons against birth-control; further, to instill into the minds and hearts of our growing young people the new ideal of sex, which embraces a single standard of morals for both men and women as well as rational scientific ideals of the need of greater self-control, earlier marriages, with prevention of conception, to avoid burdening themselves with offspring that they cannot properly care for.

Now let us briefly glance at the principal reason for such a movement. As physicians we are particularly in a position to know that hundreds of children are born in this country, in spite of our wealth, into conditions physical and moral which mean neglect, high infant death-rate, insufficient food, poor education, with inevitable subsequent delinquency, vice, and crime. Should any doubt this statement let them inquire into the records of the juvenile and other special courts dealing with youthful criminals. Other hundreds are born of parents with tainted heredity or acquired disease; these are the children of our syphilitics, epileptics, defectives, and degenerates. Again there are those hundreds who are conceived against the will of both parents, but particularly the mother. Who of us has not heard the heart-broken confessions and appeals of many decent, honest working women, or even of the middle class, who are struggling with a small family budget to

[1]Read before the joint session of the Chicago Gynecological Society and the Chicago Medical Society, February 16, 1916. (For discussion see p. 234.)

keep up and do the best for the children already in the world, and who in many cases are already worn out from the struggle, begging and appealing for relief from the impending calamity? Naturally we refuse to perform an abortion, for obvious reasons. We argue with the poor woman, extend to her our sympathy, and urge all the classical things in favor of having one more child, but most of them remain unmoved and leave your office with determination on their faces to get relief regardless of danger of infection, invalidism, or even death. Those are not the only ones that seek abortion; there are other hundreds, especially among the poor working girls, who are betrayed by promise of marriage and other alluring prospects and find themselves pregnant and deserted, with almost unsurmountable economic difficulties to face as well as loss of reputation.

No matter what your ideas of the sacredness of human life and the criminality of performing abortions, your heart aches while you send a woman out of your office, knowing that she is surely going to a quack or an unscrupulous midwife.

Another reason is the definite change in the attitude of the modern woman in regard to her special function as a woman and her place in the social order.

We may call it the feminist movement or anything else. The fact is that it manifests itself in hundreds of different ways; it cannot be ignored or argued down with the old-fashioned idea that "motherhood is the only sphere of woman."

The modern woman feels more keenly than ever before her duty and responsibility for the race. Her maternal feelings are no less developed, but because she knows that the mortality from childbirth is still high and the morbidity still higher, she is unwilling to be subjected to involuntary motherhood. She knows further that a great many women suffer in health and spirit from too frequent pregnancies, childbirth, and lactation. She knows the children born at too short intervals are likely to be delicate and feeble. She also knows that the death-rate is greater in large families, and it is the mother and not the father who suffers most acutely when the family income is not sufficient to provide decent shelter and clothing for children already existing. Finally, the mother also feels that she has a place in the political and social activities of life and that she cannot discharge her duties as a citizen and a member of society without a certain amount of time and study. Therefore she feels that she ought to have the power of choice as to the size of her family. It is this feeling that frequently makes the woman of even the lowest class discontented with marriage when the husband, through ignorance or indifference, fails to recognize her right of ownership over her own body. In many cases, consciously or unconsciously, she rebels against involuntary motherhood, which leads to estrangement and divorce. These conditions likewise cannot be corrected without definite and radical changes in our treatment of birth-control.

I confess that I do not know of any ways and means of improving the present situation, save those proposed by the advocates of this movement which deals with birth-control and economic betterment of the working classes.

Many objections are made to their proposals. Some are based on religious ideas, some on moral, some on hygienic. Thoughtful people will not deny that the problem is difficult and complex. Complete freedom in birth-control may result in certain abuses and new forms of immorality. These we shall meet as they develop. As far as the religious objection is concerned, one must admit at the outset that no amount of argument is likely to lead to any agreement; it is better, therefore, to frankly agree to differ. As to the moral objection, the form in which it is usually put begs the question at issue. Morality is the science of conduct of human relations, and that which is injurious to ourselves or to the community is immoral. That is moral which is beneficial to the individual and the community. Moral conceptions change with the needs and conditions of individuals and communities. From that standpoint, by allowing the present conditions we permit immoral actions. It is from this standpoint that freedom of birth-control will benefit

the individual as well as society. This freedom of control will lead to a decrease of abortions. This is a well-established fact, for in countries where such knowledge is allowed to be disseminated, as in the case of Holland and New Zealand, the number of abortions and of unfit children is diminished. This is a blessing to society and consequently must be moral in the true sense of the word.

That birth-control and early marriages would diminish venereal disease is also a well-established fact.

We hear, too, of the danger of race suicide in event of removal of legal restrictions upon birth-control. In answer to this argument I want to call to your attention the fact that birth-control has been practiced more and more for the past several decades by the intelligent, comfortable, and professional classes of this country and abroad. They have, apparently, had very little difficulty in obtaining the information from competent physicians. Birth-control has been practiced among them to such an extent as to fill some of our sociologists with the fear that the least fit as to heredity and environment will outnumber the fit. Yet these very people who have used means of control do not remain childless, but have from one to three children (as has been proved by the college women). The claim is that with smaller families comes better care of offspring which diminishes the mortality and in that way evens up matters. And it seems to me, if people have no maternal and paternal feeling to make them wish for offspring when happily married, that it is really better for them not to have children.

The world has too many children among the poor already and not enough among the better classes. We hope the birth-control movement will correct this condition. As to the danger of the use of these preventives, those who have studied the subject know more than those who have not, and there is ample evidence to prove the utility of preventives. Nations in which preventives have long been in use have shown themselves most vigorous and civilized. The danger will exist only if the knowledge is distributed by persons who have not scientific knowledge. It is the physician who should lead in this enlightenment and he should not leave it to the quacks.

Finally, it is claimed that the dissemination of knowledge of methods to prevent conception would lead to great laxity among young unmarried persons. Very likely this would happen to some extent; but would the consequences be worse than those which daily stare us in the face and in the newspapers?

In discussing the question of birth-control we must try to prevent the lay public and even some of the profession from confusing it with the other difficult and grave question of the induction of abortion. The birth-control movement deals only with the means of preventing conception and the dissemination of knowledge concerning the intelligent use of such means, as well as with the exercise of self-control. It is not unnatural that the great evil of abortion should loom large in every discussion of sex relations. It is to be hoped that before long the profession will face that question courageously and honestly, realizing that to continue to ignore it is not to save life but to play into the hands of the quack and abortionist, who make the destruction of life the most profitable part of their business.

AN ADDITIONAL CONTRIBUTION TO THE THERAPEUTIC VALUE OF RADIUM IN PELVIC CANCERS[1]

By HENRY SCHMITZ, A.M., M.D., F.A.C.S., Chicago.

IN accordance with the statement made in my previous articles (1 and 2)— "The Action of Radium on Cancers of the Pelvic Organs," and "The Primary Results of Radium Treatment in Uterine and Rectal Cancers"— in which reports were made as to the use of radium in 41 cases of cancers of the pelvic organs, I submit below a review as to the present status of these cases and include in addition the histories of cases which have come under my care up to April 1, 1916.

The total number of cases of malignant disease of the pelvic organs treated to date is 80; 62 of these are uterine, 10 rectal, and 8 vesical cancers (see Table 1).

The clinical results of radium therapy depend upon the method of application. My technique has been changed repeatedly as I have gained experience in the course of two years, and therefore I believe it would not be amiss to describe my present method of applying radium.

TECHNIQUE USED IN RADIUM THERAPY

The therapeutic action of radium depends on (1) the amount of radium element, (2) the method of screening, (3) the extent of the time of the exposure, and (4) the distance maintained between the radium and the tumor mass.

The quantity of radium at my disposition is 100 milligrams of radium element in the form of radium barium sulphate of a purity of about 60 to 70 per cent. However, I have used uniformly 50 milligrams in treating the cancers referred to in this monograph. The duration of a course of treatment has been on an average of 40 to 48 hours, i.e., 2,000 to 2,400 milligram hours. The radio-active substance is applied at intervals, so that a course of treatment does not consume more than eight days. The first application lasts from 20 to 24 hours. The interval time between the applications varies from 12 to 36 hours. The amount of milligram hours of radium element necessary in a given case is determined by the local conditions present, which are elicited by a painstaking bimanual examination. A carcinoma extending a distance of 1 centimeter from the radium becomes destroyed by the γ-rays of 50 milligrams radium element within 12 hours; an exposure of 48 hours is necessary to destroy carcinoma-tissue within a distance of 2 centimeters, and 128 hours within a distance of 3 centimeters. The duration of the exposure may be reduced by employing larger amounts of radium element. For instance, if γ-rays of 100 milligrams of radium element are used then the time exposures given above may be practically reduced by one half. However, the use of larger amounts of radium element, say 200 or 300 milligrams, does not proportionally increase the action of radium, unless the tubes are inserted in different regions of the tumor mass, so that each 100 milligrams acts independently of the others (3).

These facts — the determination of the amount of γ-rays and the duration of treatment necessary to influence a carcinoma-growth — are based on the law of radiation and on experimentation in the living human body.

The intensity of the action of radium rays varies inversely as the square of the distance. If the distance of the tumor from the source of energy, i.e., the radium, is doubled, the time of exposure must be quadrupled. Should the radium capsule be kept 1 centimeter from the tumor mass, then the time of duration of the action of radium in the first centimeter of tissue must be quadrupled, in the second it must be multiplied by nine, and in the third by sixteen (4).

The experiments in the human body were carried out in recurrent breast cancers, characterized by the formation of multiple nodules. A nodule was removed under local

[1] Inaugural thesis, Chicago Gynecological Society, June 23, 1916. Received for publication May 7, 1916.

TABLE I—PELVIC CARCINOMATA

Treated with Radium from April 1, 1914, to April 1, 1916

Variety of Cancer	Total Number	Primary Subjective Result		Primary Objective Result		Present Condition		
		Improved	Unimproved	Improved	Unimproved	Clinically Well	Unimproved	Died
Carcinoma uteri inoperabile	35	23	12	21	14	11	4	20
Carcinoma uteri operabile	12	11	1	11	1	7	2	3
Carcinoma uteri recurrens	15	10	5	10	5	4	2	9
Total	62	44	18	42	20	22	8	32
Carcinoma recti	10	6	4	6	4	2	3	5
Carcinoma vesicæ	8	7	1	5	3	3	2	3
Grand total	80	57	23	53	27	27	13	40

anæsthesia and subjected to a microscopic examination to determine the pathological nature. Then the γ-rays of 50 milligrams of radium element were applied for 4 hours to another nodule, for 6 hours to a second one, for 8 hours to a third one, for 10 hours to a fourth one, for 12 hours to a fifth one, and so on. After ten days the nodules were removed and subjected to a microscopic examination. We were particularly careful to note the distance of the nodule from the skin surface. In this manner we could repeatedly demonstrate the fact that the γ-rays of 50 milligrams radium element destroyed carcinoma-tissue within a distance of 1 centimeter after an application of about 12 hours, i.e., 600 milligram hours. The receptivity of carcinoma-tissue toward the γ-rays varies depending upon the age of the individual and the corresponding difference in the vascularity of the tissues as well as on the variety of the carcinoma-cell (5). For practical reasons the above dosage of milligram hours, when 50 milligrams of radium element are used, may be considered as lethal.

The method of screening is simple as γ-rays only must be used in pelvic organs. The α-rays are arrested by the glass capsule, in which the radium salt is contained. The β-rays are absorbed by 1.2 millimeters brass, silver, or lead. Brass screens were used as they are cheaper and cleaner than the other metals. The secondary or Sagnac rays formed in the metal screens are arrested by a para rubber tube of 2 millimeters thickness or about six to eight layers of No. 2 gauze surrounded by a rubber finger obtained from a discarded surgical glove. The screens are built so that the radium capsules may be arranged in tandem or twin formation. The tandem is used intra-uterinely, rectally, or vesically, while the twin is employed on large surfaces as a crater in the cervix. The local conditions found present, therefore, determine the arrangement of the capsules (see figs. 1 and 2). We are especially careful to protect normal tissue from the γ-rays by suitably formed lead plates protected with heavy rubber sheeting to arrest any secondary rays that might form in the lead. We choose lead sheeting for this purpose as it is pliable and can be cut with scissors to any size or shape desired.

The rays of radium strike the tissues with a greater uniformity of intensity the further the distance between the capsule and the tissues, as the rays become almost parallel or homogenous. This principle is advocated by Dessauer in massive roentgen raying (6). The advantage thus gained is more than lost by the decrease in the intensity of the rays (7). We attempt to bring the capsule as close to the tissues as possible.

Crossfiring should be employed whenever possible (8). If a carcinoma is found in the anterior rectal wall, a radium capsule should be inserted in the rectum and another one in a corresponding position within the vagina; if in the posterior rectal wall, in the rectum and between the anal or perineal fold; if in the posterior vesical wall, in the bladder and vagina; if in the anterior vesical wall, in bladder and suprapubically, and so forth.

Special radium carriers are required for

rectal and vesical applications. For the former I use a cup with a perforation in the center and held in place by double rubber bands fastened to a belt around the abdomen. The radium carrier is attached to a brass rod which is surrounded by rubber tubing. The latter arrests also the secondary rays. The length of the rubber tubing is determined by the distance of the growth from the cup. The brass rod passes through while the rubber tube rests on it. The carrier by this arrangement remains movable and therefore becomes automatically adjusted to any position the patient might assume. In vesical cancers I place the radium capsule in a urethral catheter. Two fenestra are made in the catheter beneath the radium capsule. As vesical cancers are usually located in the trigone, the position of the catheter within the bladder is indicated by the escape of urine through the tube. The latter is then secured in place by adhesive plaster. A rubber tube attached to the catheter directs the urine into a bottle. Continuous drainage is thus secured, making possible long continued applications of radium within the bladder.

After the first course of radium treatment the patient is requested to return weekly for re-examinations. The latent action of radium reaches its height within 21 days. Should the patient not exhibit at this time a marked improvement in the local condition, indicated by a decrease in the size of the tumor, another course like the first one is given. If the patient shows a marked improvement, then the second séance is postponed for another three weeks. Further applications are thereafter given when indicated by a persistence or a reappearance of the tumor. The patient is requested to return for examination every four weeks after a clinical cure has been obtained.

Strictest asepsis must be observed in the application of radium. Instruments and applicators must be rendered sterile by boiling. The field of operation must be prepared as for any operation. The surgeon, also, must prepare as he would for the performance of any operation and protect the hands with sterile rubber gloves.

THE USE OF MASSIVE ROENTGEN RAYS IN CONJUNCTION WITH RADIUM TREATMENT

We cannot determine by bimanual examination whether the regional lymphodes are or are not metastatically invaded by the carcinoma. Therefore, we apply massive X-rays to the glands through the anterior abdominal wall by the multiple field cross-fire method of Gauss. We use Coolidge and water-cooled roentgen tubes. As the vacuum or hardness obtainable in the water-cooled tubes is higher than in the Coolidge, we prefer the former. However, the use of the roentgen tube involves a greater expenditure in the time of the exposure, but the higher vacuum obtainable insures a greater penetration. This, after all, determines the preference for the water-cooled tube.

Thirty to fifty erythema doses are necessary to destroy a malignant growth within 20 centimeters of the surface of the abdominal wall. It requires seven times this amount, that is 350 erythema doses to remove metastases near the posterior pelvic walls, which are about 10 centimeters distant from the suprapubic region (9). The roentgen tube should have a hardness of twelve to thirteen and a half, as determined by a Wehnelt penetrometer. It should carry a critical current of 4 to 5 milliamperes. Its constancy must be maintained by a continuous flow of cold water around the anode and an interruption of the current for a half second out of every second while in use to keep the tube cool, and thereby retain the hardness for an indefinite length of time. The distance of the anode from the body should be 21 centimeters. The rays should be filtered through a three-millimeter aluminum screen, to exclude the soft rays. Under these conditions 10 to 12 erythema doses may be obtained per hour. If three séances of one hour each are given daily, 10 to 14 days are necessary to reach an amount of 350 erythema doses. If we use six fields as portals of entrance, we must apply about 60 erythema doses to each field. Bumm does not hesitate to apply 100 to a field (10).

The time of exposure can be reduced by using a Coolidge tube. L. G. Cole states that an erythema dose may be attained in one minute with a three-millimeter aluminum filter.

TABLE II.—CARCINOMA UTERI INOPERABLE

Case No.	Hospital Number	Name of Patient	Age	Civil State	Para	First Symptom	Result of Examination	Date of First Symptom	Date of Treatment	MGH	Primary Result	Date and Character Surgery	Present Condition
12	Augustana 38223	Mrs. Pauline H.	48	W.	O	June, 1912 Hæmorrhages	Cancerous ulcer involving vagina. Very cachectic.	June, 1912	5-30 to 9-24-14	10375	7-3-14 Subjective cure	11-13-13 Cautery	Died March, 1915.
22	Augustana 39778	Mrs. Emilie K.	66	M. 43	II	Jan., 1914 Hæmorrhages	Ulcer left side of cervix involving left vaginal wall. Uterus fixed.	Jan., 1914	5-12 to 7-5-14	6320	Good	4-22-14 Cautery	Died Jan., 1915.
24	St. Mary's 24096	Mrs. J. McC.	47	M.	O	For three mos. Hæmorrhage	Cervix forms a crater. Uterus firmly fixed. Mass in lig. lata.	Jan., 1914	4-18 to 8-16-14	7500	Good	3-18-14 Cautery	6-17 became worse. Now refractory. Died.
26	St. Mary's 23957	Mrs. E. M.	52	W.	I	For ½ yr. Menorrhagia	Cervix and vagina one crater extending into lig. card.	1912	4-2 to 6-11-14 7-20 to 27-14	7875 3100	Good	3-8-14 Cautery 7-14 Abd. Hyst.	Died from invasion of rectum.
29	Augustana 40202	Mrs. M. R.	43	M.	III	Sept., 1913 Hæmorrhages	Ulcer right half cervix extending into right lig. latum and vagina.	Sept., 1913	6-7 to 8-5-14	9250	Good	8-5-14 Abd. Panhysterect	Died 11-20-14.
31	Willard 27036	Mrs. John S.	50	M.	I	Jan., 1910 Hæmorrhage	Uterus a mere shell, firmly adherent to rectum. Recto-vaginal fistula.	Jan., 1910	4-4 to 6-17-14	8312	Good	1910 Cautery	Oct., 10, 13. Colostomy. Died Dec. 14. Metastasis Liver.
32	Augustana 30321	Mrs. Ingeborg T.	53	M.	I	For 6 mos. discharge. For 1 mo. hæmorrhage	Crater of cervix invading post-vaginal wall.	11-1-13	4-1 to 9-9-14	9043	Good	3-5-14 Cautery 4-24 Abd. Hyst.	4-1-16 Well.
34	Augustana 39469	Mrs. L. W.	35	M.	O	Pain and Hæmorrhage	Cervix ulcerated. Vaginal vault invaded. Infiltration of parametrii.	Dec., 1913	4-1 to 7-31-14	8700	Good	3-19-14 Cautery 6-11-14 Abd. Hyst.	Died Aug., 1914. Carc. vesicae.
35	Augustana 40568	Mrs. W.	48	M. 30	XIII	For 5 mos. Menorrhagia	Mass involving uterus, vagina, parametrii. Myocarditis with discompensation.	Feb., 1914	7-19 to 8-9-14	3750	Refractory		Died Aug. 9, 1914. Discompensation of heart.
39	Augustana 41305	Mrs. Lillian R.	39	M. 9	II	July, 1914 Hæmorrhages	Cervix large indurated ulcer extending to vagina all around.	July, 1913	10-17 to 22-14	4000	Refractory	10-7-14 Cautery	Died Dec., 1914.
40	Augustana 41221	Mrs. A. N. S.	53	M.	I	June, 1914 Menorrhagia	Ulcer involving cervix and vagina all around.	June, 1914	10-19 to 11-1-14 2-9 to 11-1915	6800 1200	Good	9-26-14 Cautery	Died March, 16. Metastasis of Femur.
45	Wash. Bvd. 8902	Miss M. R.	53	S.	O	Oct., 1913 Hamorrhage	Advanced cachexia. Entire pelvis including vagina form one mass.	Oct., 1913	11-6 to 12-3-14	8850	Refractory	None	Died Dec. 14. Very advanced case.
50	West Side 28985	Mrs. M.	48	M.	O	Mar., 1914 Hæmorrhage	Uterus size of fist. Mass extends to left bony pelvis. Advanced case.	Mar., 1914	11-27 to 11-30-14	4150	Refractory		Developed infection.. Died Dec., 1914.
65	Augustana 41944	Mrs. R. T.	49	M. 24	III	For 2 yrs. pain in pelvis.	Crater involving cervix, vagina and lig. card.	Jan. 6, 1914	1-21 to 24-15	3500	Good	1-6-1915 Cautery	Vesicovaginal fistula. Died.
73	Post Graduate	Mrs. Julia H.	43	M. 27	XV	For 3 yrs. Discharge	Crater involving cervix and ant. vaginal wall. Advanced cachexia.	Jan., 1912	2-6-15	4800	Refractory		Refused further treatment. Died.
80	Augustana 42538	Mrs. Charlotte L.	55	30	O	For 3 mos. Hæmorrhages	Cervical stenosis due to tumor. Pyometra	Jan., 1015	3-12 to 26-15	2925	Good	3-10-1915 Cautery	4-6-16. Well. Working.

81	Norwegian Deaconess	Mrs. Johanna W.	63	W.	VI		Ulcer of cervix, involving vesicovaginal septum and lig. card.		3–15 to 3–1915	1700	Negative	3–15–1915 Excochleation	3–26–15. Died from sepsis.
83	St. Mary's 27649	Mrs. J. S.	65	W.	V		Mass involving cervix and lig. card.		3–20 to 4–26–15	4550	Good	3–16–1915 Cautery	Recurrence Jan., 1916. Did not return for treatm.
88	St. Mary's 27978	Mrs. Nellie DeR.	56	M. 37	II		Mass involving cervix and right parametrium		4-15 to 5-5-15	5650	5–26–15 Well	4–15 Cautery	Died July, 1915, after operation for pyonephrosis.
98	St. Mary's 28355	Mrs. Anna V.		M.		For 2 years Discharge	Uterus mere shell, adherent all around. Advanced cachexia	Two years	5—18 to 27–15 6-10 to 8-24-15	3050 3400	Well	Very advanced case	Mar. 27, 16. Well.
110	St. Mary's 28457	Mrs. Jadwiga G.	36	M. 16	VIII	Oct., 1914 Hæmorrhage	Crater involving entire uterus and vagina.	Oct., 1914	6–4–15	2400	Immediately int. vag. fistula	12–3–14 Cautery	Died. Further treatm. considered useless.
115	St. Mary's 28866	Mrs. A. W. B.	50	M. 32	V	Dec., 1914 Hæmorrhage	Advanced cachexia. Crater involving vagina, uterus, rectum, bladder	Four years	7–8–15	1750	Refractory		Died 7–12–15. Very advanced cachexia.
120	St. Mary's 29049	Mrs. B. T.	48	M.	V		Advanced cachexia. Crater cervix, vagina, parametrii.	Dec.	7-23 to 8-29-15 9–20	3350 1050	Refractory		Very advanced case. Died.
113	Augustana 43556	Mrs. F. E. P.	47	M.	I	Dec., 1914 Hæmorrhage	Ulcer of cervix. Uterus fixed.	Dec 1914	6–1915 8–28–15 3–29–16	2100 300 1000	Well		3–27–16. Well.
128	Augustana 44110	Miss M. F.	41	S.	O	For one month Dysuria	Ulcer involving cervix and upper half of vagina		8–17 to 8–26–15 9–16 to 1–31–16	1925 4075	Good		Died from sepsis after appendectomy and hysterectomy. 1–16.
141	Augustana 44801	Mrs. Anna R.	50	M.	O	For 3 months Dysuria	Involvement of cervix, entire vagina and vesicovaginal septum	Three months.	10–27 to 31–15 12–27 to 29	1200 2000	Good Good		Died Jan., 16. Post-mortem examination negative. No carcinoma.
140	Willard 29858	Mrs. Katie M.	48	W.		For 3 years Hæmorrhages	Advanced cachexia. Crater involving cervix and vagina.	Three years	8–15 to 24–15 11–12 to 3-18-16	2100 3225	Good Good	8–10–15 Cautery	3–25–16. Well. Working. Gained 50 lbs. in wt.
147	Post-Graduate	Mrs. Mamie S.	58	W.	I	Purulent at times bloody, discharge	Uterus fixed in a mass involving parametrii. Cervix and vagina present ulcer	1915 July	1-21 to 12-15-15	3800	Good		4–1–16. Well. Resumed her work.
152	Augustana 45181	Miss S. A. S.	45	S.	O	Oct., 1915 Pain	Involvement of cervix and entire vagina	Oct., 1915	12–3–15 12-24 to 3-11-16	2250 2900	Good Good	4–2–16 Fulguration of bladder papilloma	3–25–16. Genitals negative. Bladder papilloma
161	St. Mary's 30939	Mrs. Dora H.	70	M. 53	VII	Discharge	Ulcer involving cervix, and vaginal fornices. Uterus fixed.	Jan.9, 1916	1–17	600		1–11–16 Cautery	Refused further treatment.
162	Augustana 45549	Mrs. E. B.	52	M. 32	V	Discharge	Ulcer involving cervix and vagina, extending into parametrii	Feb., 1915	1–19 to 3–15–16	3700	Good	1–14–16 Cautery 2–16–16 Abd. Hyst.	5–1–16. Well.
165	Augustana 45516	Mrs. E. B.	50	M. 35	II	Discharge	Crater involving cervix, extending into left parametrium	Six weeks	1–26 to 2–10–16 3–3 to 3–18–16	2000 1800	Good Good	4–13–16 Panhysterectomy	7–12–16. Recurrence.
168	Augustana 45129	Mrs. F. M.	53	M. 33	O	Hæmorrhage	Uterus has sloughed entirely. Vesicovaginal fistula	16 months	1–30 to 3–14–16	3550	Good	10–15–15 Cautery	Has large vesicovaginal fistula.
172	St. Mary's 31395	Mrs. M. LaR.	49	M.		Hæmorrhage	Crater involving vagina, cervix and infiltrating parametrii	June, 1914	2-20 to 24-16 3–20–21	1700 1850	Good	8–2–15 Cautery	5–5–14. Free of pain.
178	St. Mary's 31638	Mrs. B. G.	34	M. 10	O	Hæmorrhage	Ulcer of post-cervical lip extending into fornix; infiltrating rectum	Dec., 1915	3–2 to 4–1916 3–27	2400 1000	Good		4–30. Ulcer has healed. No indurations anywhere.

TABLE III—CARCINOMA UTERI RECURRENS.

Case No.	Hospital Number	Name of Patient	Age	Civil State	Para	First Symptom	Character of Recurrence and of Operation	Date of First Symptom	Date of Operation	Date of Recurrence	Radium Date and Amount	Immediate Result	Present Condition
13	Augustana 40717	Mrs. A. H.	61	W.	I	June, 1910 Discharge	Recurrens: Nodule in fornix. Panhysterectomia vaginalis.	June, 1910	Jan., 1910	June, 1914	7-23-14 to 11-30-14 12000	Good	May 15. Died from intercurrent disease.
21	St. Mary's 24058	Mrs. M. K.				Since 1912 Pain	Abdominal supravaginal amputation. Involvement of entire vagina	1912	9-16 13	Immediately	4-16 to 5-28-14 5700	Good	Died Sept. 21-14. Exhaustion.
23	Augustana 39516	Mrs. McQu.	29	M. 9 yrs.	O	April, 1913	Abdominal hysterectomy. Involvement of vagina, vulva, perineum	April, 1913	Oct., 1913	Immediately	4-25 to 5-13 3375	Refractory	Died vagina, vulva and perineum were involved. 10-14.
28	Augustana 40270	Mrs. Caroline	63	M		May, 1913	Involvement of vaginal vault	May, 1913	May, 1913	Jan., 1914	6-13-14 to 6-15 2275	Good	Did not return for treatment
37	Augustana 40456	Mrs. T. M. P.	45	M.	O	Since Aug., 1912 Discharge	Abdominal hysterectomy. Mass in right parametrium	8-12 1912	8-12 1912	Mar., 14	7-10 to 13-14 3500	Refractory	Died August, 1914. Exhaustion.
48	Augustana 41612	Mrs. D. W. H.	54	M.	III	Since April, 1914 Hæmorrhage	Abdominal hysterectomy. Involvment of scar in broad ligament	May, 1913	11-22-13	9-2-14	11-22 to 11-24 220		Died from exhaustion and sepsis following cautery.
71	Augustana 42319	Mrs. Mary M.	42	M. 22	II	Since June, 1913 Hæmorrhage	Abdominal hysterectomy Mass involving scar and right parametrium	June, 1913	Oct. 1, 1913	Jan., 1914	2-15 to 5-13 8200	At first Sub. cure	Died with vesicovaginal fistula, Nov., 1915.
77	St. Mary's 27533	Mrs. Mary H.	33	M.	I	Hæmorrhage	Vaginal panhysterectomy. Involvement of parametrii		Aug. 21, 1914	Immediately	3-5 to 3-19-15 4075	Refractory	Died.
79	St. Mary's 27590	Mrs. Annn C.	52	W.		Mar., 1913 Hæmorrhage	Vaginal hysterectomy. Involvement of vagina	Mar., 1913	Mar., 1914	Immediately	3-10 to 4-5-15 3900	5-13-15 Good	8-28-15. Returns with recurrence. Non-refractory. Died.
105	Willard 29857	Mrs. Hariette E.	54	M. 36	III	Aug., 1913 Hæmorrhage	Percy cautery. Abdominal panhysterectomy. Crater involving left parametrium	Oct., 1913	6-19 15	July, 1915	6-1 to 11-15 3950 8-5 to 11-29 2100	4-25-15 Cautery 6-19-15 Abd. Hyst.	Well. 5-16-15.
116	Augustana 43718	Mrs. Ellen C.	60	W.	IV	Hæmorrhage	Crater in vaginal vault				7-9 to 11-11-15 7100	Good at first	Vesicovaginal fistula, 10-1915. 11-1915, hæmorrhages. Died.
124	Augustana 44099	Mrs. Christine M.	38	M. 13	I	For one month Hæmorrhage	Vaginal panhysterectomy. Ulcer in vaginal vault.	2-15-15	Mar. 26-15		8-13 to 12-20-15 5575	Good at first	December became rapidly worse. Died. 4-10-16.
125	Augustana 44095	Mrs. Lulu C.	47	M.	O	For 2 years Abdominal Tumor	Abdominal panhysterectomy for papilloma ovarii. Parametrii involved.	1-8-13	1-8-15		8-13 to 9-5-15 2350	Good	
135	Augustana 44503	Mrs. Mary M.	25	M. 8	III		Vaginal hysterectomy. Vesicovaginal fistula, vaginal vault		8-1-15		9-24 to 26-15 2050	Good	Had vesicovaginal fistula after operation. Refused to return.
176	Augustana 45966	Mrs. Caroline Y.	50	W.	IV	Ovarian Papilloma	Abdominal oophorectomy. Involvement of parametri and vaginal vault	Dec., 1914	Dec., 1914	One month	2-28. 1000 3-13. 1100		3-11-16. Panhyerectomy, abdominal.
182	St. Mary's 31944	Mrs. Cath. F.	52	W.	II	Oct., 1914 Sanguineous discharge	Crater and ulcer in left vaginal vault extending downward	Oct., 1914	Apr. 14, 1915	Immediate	3-29-16 2000		Apr. 28-16. Subjectively well.

TABLE IV. — CARCINOMA UTERI OPERABLE

Case No.	Hospital Number	Name of Patient	Age	Civil State	Para	First Symptoms	Result of Examination	Date of First Symptom	Date of Operation	Radium Treatment	M. G. H. to Date	Result to Date
7	Augustana 41218	Mrs. E. B.	54	M.	I	Menorrhagia discharge	Cauliflower growth of cervix, involving entire vaginal vault. Uterus fixed posteriorly	Jan., 1914	9-25 1914	10-10 to 24-14	5200	Died, Jan., 1915, from hæmorrhage.
17	Augustana 40944	Mrs. R.	39		O	Menorrhagia discharge	Nodule size of hickory nut on anterior cervical lip	Jan., 1914	8-26 1914	9-16 to 11-17-14 6-14-15	6775 2400	8-26. Abdominal panhysterectomy. Vesicovaginal fistula. Died Feb., 1916.
33	Augustana 39755	Mrs. Hilda F.	64	42 yrs M.	V	For one year discharge	Ulcer involving cervix and posterior vaginal fornix.	Apr., 1913	4-20 to 24-14	5-15 to 30-14	3525	4-20 Cautery. 4-24 Abdominal panhysterectomy. Primary result good. Absconded.
82	St. Mary's 27560	Mrs. Belle J.	36	15	II	Microscopic evidence	Negative		3-16 1915	3-21 to 3-28 1915	2550	Well, Mar., 1916.
90	St. Mary's 27982	Mrs. Jos. St. A.	49	25	V	For six months discharge	Cervix-crater extending into vaginal fornices, fixed to cardinal ligaments	Oct., 1914	4-16 1915	5-23 to 31 1915	4000	Well, Feb., 1916.
101	Willard 29417	Mrs. G. B. P.	53	33	II	For eight months hæmorrhages	Cervix-crater invading vesicovaginal septum and right ligament. latum	Aug., 1914	5-20 1915	5-23 to 30-15 Since received	4000 7375	2-15-16 Vesicovaginal fistula. Good physical condition, otherwise.
106	St. Mary's 27770	Miss D.	37	S.	O	Tumor formation in vulva for 5 years	Nodules all through vulva, especially clitoris. Inguinal lymph-nodes involved.	Jan., 1909	6-20 1915	6-30-15	2000	Carcinoma vulvæ. 3-26-16 well.
117	Augustana 43551	Mrs. Hattie H.	39	M.	VII	Hæmorrhage since 4-15-15	Ulceration of entire cervix	April, 1915	6-18-15	7-18-15	1050	6-20. Panhysterectomy preceded by cautery.
133	St. Mary's 29442	Mrs. M. P.	35	M. 14	V	Discharge 5 months Hæmorrhage 1 month	Ulcer of entire cervix invading rectovaginal septum			9-19-15	2400	Had a recurrence when treatment was begun. Died 12-20-15.
134	Augustana 44515	Mrs. E. W.	48				Ulcer involving cervical canal. Not invading surrounding tissues		10-1-15 Abd. pan.	9-23 to 27-15 11-8-15	2350 600	Recovered.
174	Willard	Mrs. K. H.	43	W.	VI	Uterine Hæmorrhage	Adnexa negative. Uterus freely movable. Ulcer involving cervix	Nov., 1915	2-14 1916	2-22 to 25-16	1750	4-26-18. No local evidence of any recurrence.
41	Wash. Bvd. 8968	Mrs. Isaac B.	52	M.	O	Menorrhagia	Ulcer in fundus uteri. Bilateral adnexitis		10-29 1914	10-21 to 23-14 11-11 to 13-19	4150	3-15-16. Well. No recurrence.

TABLE V.—CARCINOMA RECTI

Case No.	Hospital Number	Name of Patient	Age	Civil State	Para	First Symptom	Result of Examination	Date of First Symptom	Date and Character of any Surgery	Date of Treatment	MGH of Radium	Immediate Result	Present Condition
18	Augustana 39516	Mrs. Anna D.	32	M.	II	14 months Rectal hæmorrhages	Involving perineum. Tumor obstr. Rectum 2 inches up.	1901	Nov., 1913 Colostomy	6-1-15 1914	9900	Refractory	Died Nov., 1914.
20	St. Mary's 25176	Mr. Ed. J. J.	56	M.		Rectal Hæmorrhages	Ulcer 2 inches by 1 inch about 1 inch above sphincter	One year	7-2-1914 Res. of Rectum.	7-16 to 10-31-14	2175	Recovered	Died July, 1915. Metastasis of liver.
38	Augustana 40349	Mrs. Lillian J.	26	M.			Rectum obstructed by tumor about 2 inches above sphincter		Colostomy	7-29 to 8-8-14	1125	Refractory	Severe rectal tenesmus prevented further treatment. Died 11-28-14.
70	Willard 28901	Mr. A. M.	52	M.		Pain in rectum Constipation	Circular ulcer about 1 inch wide and 2 inches above sphincter	Dec. 1, 1914	Refused Colostomy	2-12 to date	17875	At first good result	Mar. 16. Patient cachectic
99	Augustana 43245	Mr. Joe St.	41	M.			Stricture of rectum about 1½ above sphincter		8-1914 Colostomy	5-19 to 7-30-15	4200	Refractory	Died.
131	Augustana 44323	Mr. R. A. H.	70	M.			Ulcerating mass extending up to sigmoid		10-4 Colostomy 9-3 Resection	9-11-15	2100		Advanced case.
153	Augustana 45160	Mrs. G.	61	M.		Hæmorrhages	Ulcer infiltrating perineal body, involving vaginal mucosa			12-6 to 1-25-16	3950	Subjectively good	3-22-16. Reports rect. vag. fistula. Subjectively very good.
157	German Deaconess	Mrs. H. Sch.	47	M. 22	III	For three years Hæmorrhages	Irregular ulcerating mass involving rectum and vaginal septum	Three years	12-23-15 Colostomy	12-31 to 2-14-16	2825	Refractory	4-25-16. Reported in an improved condition.
163	Augustana 45593	Mrs. Glen W.	32	M.	II	12-15	Tumor involving posterior vaginal wall.		12-15 Kraske	1-21 to 3-16-16	1400	Prophylactic	4-29-16. Reported well. Examination negative.
173	Willard	Mr. John P. K.	61	M.		For 3 months Hæmorrhages	Papillomatous mass in lower rectum	Three months	2-5-16 Resection	2-17-16 3-11-16	250 600	Good	Rectovaginal fistula closed.

TABLE VI.—CARCINOMA VESICÆ

Case No.	Hospital Number	Name of Patient	Age	Civil State	Para	First Symptom	Result of Examination	Date of First Symptom	Date and Character of any Surgery	Date of Treatment	MGH of Radium	Immediate Result	Present Condition
19	Augustana 40405	Mr. John E.	74	M.		Dysuria Hæmaturia	Tumor involving trigone and extending into prostate	1911	7-17-14 Perineal Cystotomy	8-3 to 9-1 1914	3150	Improved	Died Dec., 1914.
59	St. Mary's 26857	Mr. Anthony St.				Dysuria Ischuria	Recurrens. Papilloma origin: Trigone	1903	1903 Cystotomy 1910 Cystotomy	12-31-14 1-24-15	2450 1150	Bladder Improved	12-31-1914. Suprapubic cystotomy. Died 1915. Metastasis femur.
69	St. Mary's 27096	Mr. Francis T.	58	M.		Dysuria Hæmaturia	Papilloma		1-25-15 Cystotomy	1-31-15	2400	Well.	11-1915. Well.

Case No.	Hospital Number	Name of Patient	Age	Civil State	Para*	First Symptom	Result of Examination	Date of First Symptom	Date and Character of any Surgery	Date of Treatment	MGH of Radium	Immediate Result	Present Condition
107	Norwegian Deaconess	Mr. Alb. F. B.	40	M.		Tumor of abdominal wall	Recurrens. Tumor of bladder involving abdominal wall		Inoperable	5–28 to 5–30–15	1900	Refractory	Died. 6-1915. Advancedly cachectic.
150	St. Mary's 30484	Mr. Harley D.	40	S.		Pain radiating to left kidney	Tumor at left ureteral opening Vesical stone		12–3–1915 Cystotomy	12–3 to 25 to 1–28–16	2400 200	Good	Bladder functionates normally. Cystoscopy negative.
151	St. Mary's 30489	Mrs. E. T. H.	55	M.	I	Hæmaturia	Tumor of bladder wall invading vesicovaginal septum. Recurrens	1909	5–10–15 Removal of tumor	12–2 to 9 12–23 to 26	2000 2300	Good Good	2-14-16. Reported in good condition. Recurrens.
156	German Deaconess	Miss Helen P.	35	S.	O	Dysuria. Frequent urinations	Recurrens; mass involving left bladder wall, post., another ant.		2-24-15 Partial cystectomy	12–30 to 1-5 1-29 to 3-5	2550 2400	Good Poor	4-1-16. Mass involving entire right parametrium
170	Augustana 45647	Mrs. Milly St.	53	M. 30	II	Vesical tenesmus	Tumor involving neck of bladder, entire urethra, and vesicovaginal septum	Three weeks	Oct., 1915 Hysterectomy	1–29 3–26–16	1400 500	Good	Tumor disappeared.

The entire application of 350 erythema doses could, therefore, be made within 6 hours.

THE POSSIBILITY OF INCREASING THE INTENSITY AND PENETRATION OF THE γ-RAYS OF RADIUM BY EXCOCHLEATION AND CAUTERIZATION OF THE CANCER GROWTH

The extent of the intensity and penetration of the γ-rays of radium may be increased by the removal of the cancer-tissue by the sharp spoon and the cautery iron. This procedure is especially practicable in the proliferating, cauliflower growth of the cervix. Cauterization has been performed in every case in our series in which such a procedure was not contra-indicated. The result is a decided reduction in the extent of the new-growth, a corresponding increase in the penetration of the rays, and a decrease in the duration of the exposure to the γ-rays. It is a purely economical question and has no other influence on the result of the radium treatment.

It is advisable to perform a colostomy in rectal cancers. This renders the seat of the carcinoma clean, prevents absorption of septic and putrefactive material, gives the patient an invaluable relief, and makes the use of radium less obnoxious.

In vesical cancers in the male a suprapubic cystotomy should be done. The radium may then be inserted through the suprapubic tube. Injury to the posterior urethra is avoided, the use of operating cystoscopes becomes obsolete, and the objections on the part of the patient are obviated. However, the catheter procedure, as before mentioned, may also be used after a preceding dilatation of the urethra.

THE CLINICAL RESULTS

Tables II, III, IV, V, and VI give the clinical history and result of every case treated. I have discussed the histological action of radium on carcinoma-tissue in one of my former monographs (1). The reader is kindly referred to the same.

The results of the radium treatment differ depending (1) on the organ involved, and (2) on the stage of the disease. The prognosis is best in vesical, almost equally favorable in uterine and vaginal, and not so favorable, even poor, in rectal carcinomata. The value

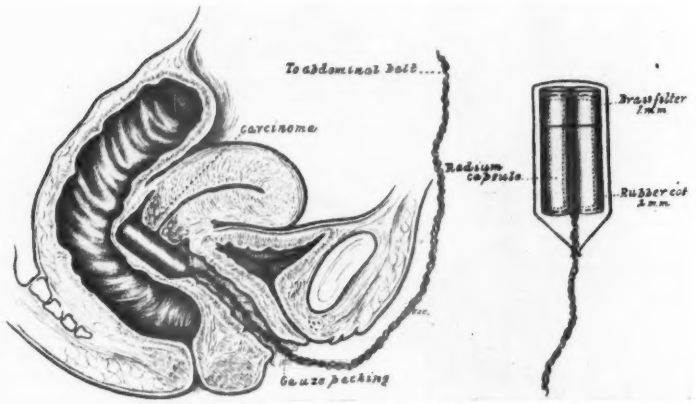


Fig. 1. Application of radium to cervix and vagina. Tubes in "twin" applicator.

of the treatment varies, depending on the operability, inoperability, or recurrence of the disease. The time elapsed in all the cases enumerated is too short to permit a discussion of the curative action of radium. However, I have two cases which succumbed from an intercurrent disease after the inoperable uterine cancer had been clinically cured by radium rays. The result of the treatment, based on microscopic examinations, will be discussed at the end of this paper.

Inoperable carcinomata. Eleven clinical cures were obtained in 35 inoperable uterine, none in 6 inoperable rectal, and 3 in 4 inoperable vesical cancers. A clinical cure implies a complete subjective and objective cure of the cancer as far as it can be determined by an exact palpation and a microscopic examination. Fourteen clinical cures were obtained in 45 inoperable pelvic cancers, i.e., 31.1 per cent. This percentage would have been much more favorable if hopeless cases had not been included. However, not a single case was refused the treatment. Seven uterine, 4 rectal, and 1 vesical, i.e., 12 cases which are included in these 45 cases were far-advanced and in a terminal stage. The 31.1 per cent clinical cures would be raised to 42.4 per cent by deducting the twelve terminal cases from the total number of 45.

The time elapsed since the beginning of the treatment in the fourteen clinical cures is as follows:

Case No.	Months	Remarks
32	24	Hysterectomized
98	11	
113	10	
128	6	Died from an intercurrent disease
141	4	Died from an intercurrent disease
140	9	
117	6	
162	4	Hysterectomized
165	4	Hysterectomized
168	3	
178	2	
69	14	
150	4	
170	4	

The favorable and palliative action of radium in inoperable cases is truly remarkable. There does not exist another remedial agent in our entire therapeutic and surgical armamentarium the application of which is followed by better results. Radium will bring about these results without any immediate or remote dangers to the patient provided the strictest asepsis and a perfect technique are employed.

Recurrent carcinomata. The primary results in recurrent cancers are as follows: Fifteen recurrent uterine, 1 recurrent rectal, and 3 recurrent vesical carcinomata were treated. Four of the uterine cancers are clinically well. The recurrent rectal cancer was in an advanced stage at the beginning of the radium treatment and remained refractory. One vesical cancer (107) was in a terminal stage when referred for treatment, one (157) was clinically cured, and another one

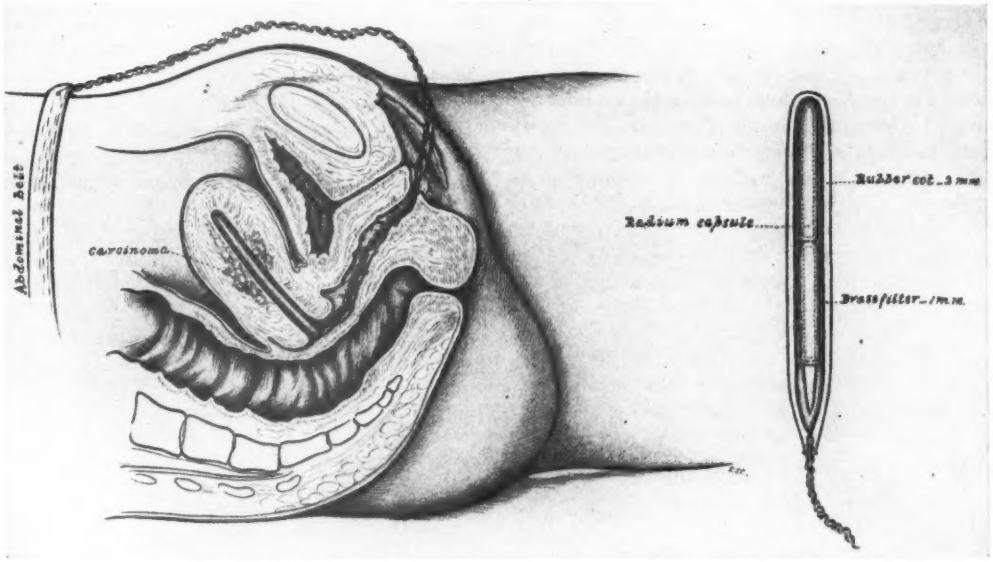


Fig. 2. Radium inserted in cavity of uterus, "tandem" arrangement.

(156) had remained refractory. The bladder was apparently improved by the radium applications but a metastatic tumor in the right lateral pelvis does not respond to the most powerful roentgen raying. Five of the 19 recurrent cases are clinically cured, i.e., 25.8 per cent. If the five advanced and hopeless cases are subtracted from the above total, then the per cent of clinical cures would be 35.7.

The elapsed time since the beginning of radium treatment in the clinically cured recurrent cases is:

Case No.	Months
105	10
125	8
135	7
176	2
151	5

The prognosis of radium treatment in recurrent cancers is, therefore, not as good as in the inoperable cases. Especial care is necessary in these cases to avoid injury of neighboring organs and contiguous tissues by the radium rays.

Operable carcinomata. The application of radium following radical excision of the uterus and adnexa for carcinoma is a purely prophylactic procedure. Carcinoma-cells that have become spilled throughout the wound area during the progress of the operation, or carcinoma-tissue that has been inadvertently left behind may, thereby, be effectually destroyed. This fact has induced surgeons to increase the percentage of operability of their cancer cases because of the possibility of subsequent radium application after the radical operation. Cases No. 90, 101, 106, 133, and 188 were really inoperable cases. Singularly enough the first three have done remarkably and are well, while the last two have not been benefited by the surgery and radium.

An opinion as to the value of radium in operable cases cannot be rendered. The improvement or cure must be credited to surgery. Otherwise the time elapsed since the operation is too short to permit an expression as to a permanent or anatomical cure. When these cases are followed up carefully and the character of malignancy is considered from the microscopic specimen and the local condition during operation, then the conclusion must be drawn that radium favorably influenced the primary result of the

operation. Medullary epithelial-cell cancers occurring especially in young individuals may be g ven a respite for years, where formerly without the X-ray and radium they could not even be benefited by an operation and rarely left the hospital alive. The time elapsed since the operation and radium treatment is as follows:

Case No.	Months
32	13
90	12
101	11
106	10
117	10
134	7
174	2
41	18
163	6
173	2

Cases 162 and 165 succumbed to an intercurrent disease after a clinical cure of the uterine carcinoma had been obtained. The first case died from sepsis following an appendectomy and abdominal panhysterectomy. Microscopic examination of tissues removed from the uterus did not show carcinoma. Case 165 died suddenly from a dilatation of the heart. The pelvic organs, para- and perimetrium, the pelvic parietal peritoneum from the brim downward, also rectum, bladder, and urethra were removed post-mortem and *en bloc*. Microscopic examinations of all the tissues were made. None of the sections showed carcinoma-cells. This result is not interpreted as an anatomical cure of cancer, yet it demonstrates the remarkable changes caused by radium in carcinoma-tissue. Those parts which before treatment showed cancer-cells were now free from macroscopic and microscopic evidence of the disease (11).

SUMMARY

1. The therapeutic action of radium depends on a correct technique, which must be based on a careful physical examination of each patient.

2. The result of radiumtherapy in inoperable and recurrent cancers surpasses those of any other known therapeutic agent.

3. The prophylactic use of radium in operable cancers increases the percentage of operability and probably the efficacy of the operative procedure.

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SIMPLE STERILIZATION OF WOMEN BY CAUTERY STRICTURE AT THE INTRA-UTERINE TUBAL OPENINGS, COMPARED WITH OTHER METHODS[1]

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SUMMARY

CONTRACEPTIVE measures are difficult to establish as the invariable rule because of their handicaps, the self-control demanded under emotional stress, and a degree of uncertainty accompanying each procedure. Section of the vas deferens, though simple, is not accepted by the male, and mere ligature cuts through. Also, of the pair, he is not the one who requires safeguarding. Ovarian shrinkage by X-ray is neither sure nor is its duration determined. Chemical slough stricture inside the upper uterine angles as advised by Froriep in 1850 was given up, but is worthy of new study. The various operations on the fallopian tubes involve opening the abdominal cavity from above or below, which is never justifiable for this purpose alone, while most of the women for whom it is indicated are poor subjects for operation. Moreover, operations call for the hospital and weeks of disability and may be followed by dragging adhesions; and there is a small percentage of danger to life. The only outlook for a simple and sure method, and that without risk or loss of time and with but little pain, seems to be through closure of the tube, where it enters the uterus, by a stricture produced as the result of a burn with the fine-tipped cautery electrode, a procedure simple enough to be done in the office. Of course all sterilizing measures are predicated on childbearing, in any given instance, being a grave risk to life or productive of permanent ill health.

Steps of procedure. Time selected, 7 to 10 days after period (for least vascularity and thickness of lining).

Location. Hospital, if the patient is sensitive; office, usually.

Technique.

(1) Loose clothing, empty bladder.

(2) Lithotomy posture (or Sims).

(3) Bimanual examination.

(4) Sims speculum, tenaculum in cervix.

(5) Injection of 5 to 10 minims 10 per cent novocaine adrenalin solution into uterus with Skene intra-uterine pipette and pressure; also application to vaginal cervix and vagina, as anæsthesia controls. After 10 minutes and due bleaching proceed to—

(6) Test the shape and length of cavity by ordinary uterine sound; this length noted.

(7) Slide on cautery sound goes to same measure.

(8) Burn of some spot on external os, with slight pressure, until wire tip is buried, to serve as a cautery control. Note time needed.

(9) If cervix is hard, burying of tip in an anæsthetized place on the vaginal wall as control. Note of required time.

(10) Cautery sound passed to cornu; held there, without pressure, the same length of time as needed to bury wire tip in cervix or vagina, with same amount of current.

(11) Repeated on opposite side.

(12) Watching slough and scar form on cervix or vagina. When firmly contracted, one may be able to test the tubes for patency by the Cary method—injecting a silver solution into the uterus under pressure, and securing an X-ray shadow of the distended uterine cavity, and also of the tubes, if they are open.

STERILIZATION OF WOMEN

A bare outline of the various procedures follows:

(a) By opening the abdomen; (b) by intra-uterine treatment.

(a) *By opening abdominal cavity.* (1) *Removal of the ovaries* is inexcusable if the ovaries are sound, as disturbances of sudden climacteric and sexual apathy result. This method has been abandoned.

(2) *Removal of the uterus*, leaving ovaries and feelings intact, is unwarranted except

[1] Read before joint session of the Chicago Gynecological Society and the Chicago Medical Society, February 16, 1916. (For discussion see p. 234.)

in case of tumor, uncontrollable bleeding, or bad prolapse.

(3) *Removal of the tubes* together with wedge at cornu is certain, but must be delicately done not to damage ovarian circulation with resultant shrinkages. It is not easily done in vaginal operations.

(4) *Exsection of portion of tubes.* (a) Of wedge at cornu, only. This is certain, but more surgery than in *b* and *c*. (b) With burial of proximal end under peritoneum; no pregnancies reported following it. (c) Simple removal of piece (best with proximal ligature only). This is practically certain, as only two pregnancies are known to have followed.

(5) *Ligature of tube*, single or double; some pregnancies follow — in women and lower animals. Any kind of tubal ligation or removal of a section (except into cornu) has resulted in an open end (42 per cent) and has occasionally been followed by restoration of continuity, but pregnancies following any tubal operation are infrequent enough to be curiosities. Any tubal ligatures may result in hydrosalpinx (although abdominal end of tube is wide open) as shown in animal experiments and in human beings.

(6) *Tubal ampullæ fastened into vagina* — on occasion of vaginal cœliotomy — has been rarely tried; in my patient, tenderness at these openings persisted.

(*b*) *By intra-uterine treatment.* (1) Obliteration of the whole uterine cavity by steaming (atmocausis) is difficult to control and has been abandoned.

(2) Atresia produced at entry of tube into the cavity of the body of the uterus by (a) chemical corrosion slough, circular scar closure; (b) cautery burn, slough, circular stricture — action on selected spots, area of damage readily kept within limits.

That there is a field for study and for better methods than we have had is shown by the difficulties with all other ways of safeguarding the woman to whom pregnancy means serious risk to life or health.

OBJECTIONS TO CONTRACEPTIVE METHODS

Unless we believe in asceticism, with marriage as a brother-and-sister relation, we must instruct patients in methods of birth-control. The difficulty concerning these several methods, whether withdrawal, vaginal suppositories, womb veil, or stem, after-douche, or male cover, is that where most needed they are likely to be least used, and for two reasons; the forethought involved, the watchfulness never to be caught off guard, the self-control and unselfish consideration for the mate, are demanded of a man, a woman, or a pair swept away by passion; and, further, they are required of the rough workman or dull peasant. This is a big task in training, particularly as we must ask most of the least intelligent if we desire to breed up and not down. Always spontaneity of caress is to be coupled with preparedness; the enchantment with a measure of fearfulness.

Since the gratification is mostly on the part of the man (because of the present lack of premarital teaching and post-marital training and the dread of pregnancy always present) it is up to the man to accept the handicap — such as the cover. And the selfish man refuses.

After very considerable experience with solid, cylindrical, wholly intra-uterine stems (for anteflexion and for premature menopause, placed so that they may remain continuously for years) I make bold to voice the belief that we shall eventually adopt, as a means of security, the unintermittent wearing of some very simple Y-shaped device, entirely intra-uterine, easily placed or removed, while for temporary guarding we shall chiefly trust to the cover, tested and lubricated.

OBJECTIONS TO STERILIZATION OF HUSBAND

Let us pass by the question of defective and diseased males that should be sterilized. Let us grant for the sake of argument the general claim that since the male receives most gratification (in some cases all the pleasure and all the recurrent desire) therefore all the preventives should be his. Nevertheless one may yet hope to be able to suggest without offense that there is a basis for a scientific or legal stand to the following effect. Of the pair, since the woman is the one who needs safeguarding, the paralysis of the man's procreative (as distinguished from his

copulative) ability is beside the mark and is attacking the wrong end of the problem in the married.

A claim may also be made for immunity from sterilization on the part of the husband which he could hardly, with good grace, voice himself; namely, the possibility of future marriage and the desire for progeny from such marriage. This reasoning would apply particularly when the wife is an invalid — less to her who has overborne.

For the male there is a relatively uncomplicated method of sterilization with slight loss of structure or of time. Vasectomy, or the removal of a piece of the conduit above the testicle, as it runs close under the skin of the scrotum, by the use of local anæsthesia, has become a standardized procedure and has been accepted by the laws of several states for the sterilization of the defective and the criminally insane. For the man who desires a method which would permit of resumption of function, should he care to have children later, reuniting of the cut ends has been proposed (or else simple ligation of the duct). Through a small incision in the scrotal skin the vas deferens is brought to the surface. A fine silk or linen ligature or silver wire is passed about it and drawn snugly enough to obliterate the caliber of the duct but with intention not to cut it through. The ends of the ligature are cut close, the duct dropped back, and the skin closed. The ligature becomes encysted. A test made of the semen shows all other elements, and unaltered bulk, but no spermatozoa. If at some subsequent time it is desired to resume this capability for fertilization, the wound can be reopened and the little ligature cut off. But experiment has shown that, as with other ligatures, with mucous lining in apposition with mucous lining, and particularly with pressure from behind, it is difficult or impossible to shut off a canal.

While criminals can be forced to submit to the operation it does not prevent their living a loose sexual life. It may indeed foster such license, since cohabitation is safeguarded from the danger of impregnation. But it does prevent the degenerate and the criminal thus treated from propagating their kind. The trouble with either operation, as one sees it in practice, is that although many a husband comes begging for a sure means of prevention after he has produced four or five children, or because of his wife's tuberculosis or Bright's disease, yet no man has been found willing to submit to the operation in this writer's experience and in that of many others.

As to the uncertainty of ligation of the vas deferens, all the data bearing on the difficulty or improbability of closing a duct by muco-mucous apposition would apply; also no ligature except silver wire will last. Fraenkel's animal experiments have an interesting bearing. Silk, if too thick, suppurates; if too thin, absorbs. Thick silk tied with moderate pressure cuts into the canal of the fallopian tube of rabbits. In 4 cases, with silk, the canal was found broken into in 15 to 20 days. In 8 cases using thick silk, the lumen was present within 23 to 90 days. There were experiments on 26 rabbits on a tube 1 to 2 mm. in thickness and therefore comparable to the vas deferens. In some few cases Fraenkel cut the tube or cut out sections of it or even used the cautery, yet he could not close the canal except in rare instances. With these various methods, 42 per cent of these fallopian tubes stayed open. In more than one-half of his ligated tubes the ligature worked in far enough to open the lumen, there being no difference between thick and thin silk; the opening into the peritoneal cavity occurring under the knot or opposite it. Once, plain catgut was found present at 157 days and once silk absorbed in 14 days. He suggests silver wire or silkworm as a more permanent ligature. In one case No. 14 iron dyed silk had cut across the tube and lay all outside it, the re-established tube with its lumen perfect, the ligature and its knot intact and encapsulated.

That simple removal of a piece of the vas may not suffice is shown by the following instances. In two cases Fraenkel cut a gap out of the fallopian tube of the rabbit 1½ cm. long, yet these tubes remade themselves perfectly macroscopically and microscopically. With double ligature and simple section

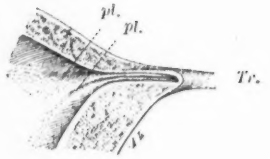

Fig. 1. Orifice of the tube open and spread out to show the longitudinal folds (Guyon). Virgin uterus.

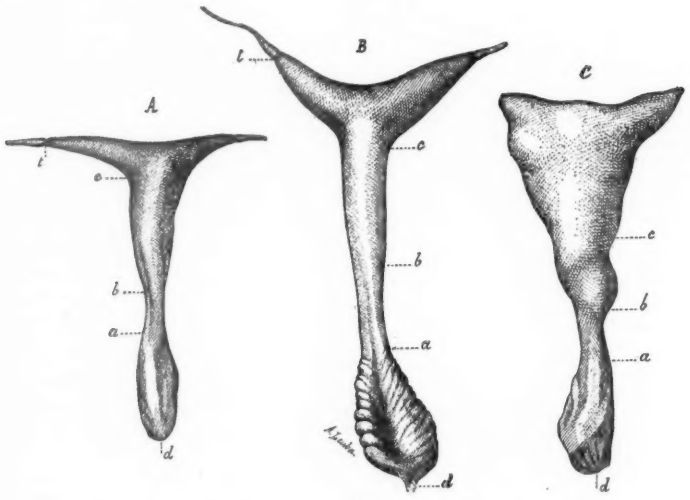

Fig. 2. Casts of the uterine cavity (natural size), after Guyon. *A*, Cast of uterine cavity of virgin 17 years old; *c*, cornu of uterus; *cb*, inferior segment of body; *ba*, isthmus; *ad*, cervix; *t*, tubes, slight narrowing at the point of junction of their cavity with that of the body. *B*, Cast, nullipara 42 years old. The same letters for the same parts. The horns are longer and the superior segment more developed. *C*, Cast of cavity of uterus of multipara (same organ as Fig. 5) triangular form of cavity of body; enlargement and deformity of the uterine horns.

no restoration occurred. In animals there is easier regeneration of organs than in man: yet Zweifel's woman showed just such reconstructive power in her tube. Double ligature and a simple cut across would seem to be indicated. This would facilitate a reuniting later, if such were desired, though success is doubtful.

OBJECTIONS TO OPERATIVE STERILIZATION OF WOMAN

Every laparotomy involves a certain percentage of risk, however simple the procedure undertaken inside the abdomen. There is always the possibility of bowel adhesion or of omental drag, and these adhesions may give more or less discomfort. There can hardly be more than one answer to the question whether a method with any death-rate at all — small as that rate may be — and possible complications afterward, is justifiable when done largely for the safeguarding of sexual gratification on the part of husband and wife. No man of fine feeling would ask his wife to submit herself to such a risk, even with powerful physical impulses on her side. Nor is it to be forgotten that a laparotomy, even a simple one, involves from one to three weeks in bed, and even with a cross incision like the Pfannenstiel, with its hidden scar, care needs to be taken for some months on account of the possibility of hernia.

For the sterilization of women all the procedures, save one, have involved entering the peritoneal cavity through an abdominal incision or through a vaginal incision. In either case the tubes are tied, or else tied and cut and one end of each buried. Or the tubes are removed. Removal of the tube is so likely to disturb ovarian circulation, and so prolongs the operation, that the most popular method is double ligature and burying the proximal ends. Ligature with section without burying has resulted in some cases in a reopening of the tied tube and pregnancy has followed. It is said to be possible to restore a tube by approximating the cut ends or by insertion of the cut end into the uterine cavity. It should be made clear, however, that success under these conditions is problematical.

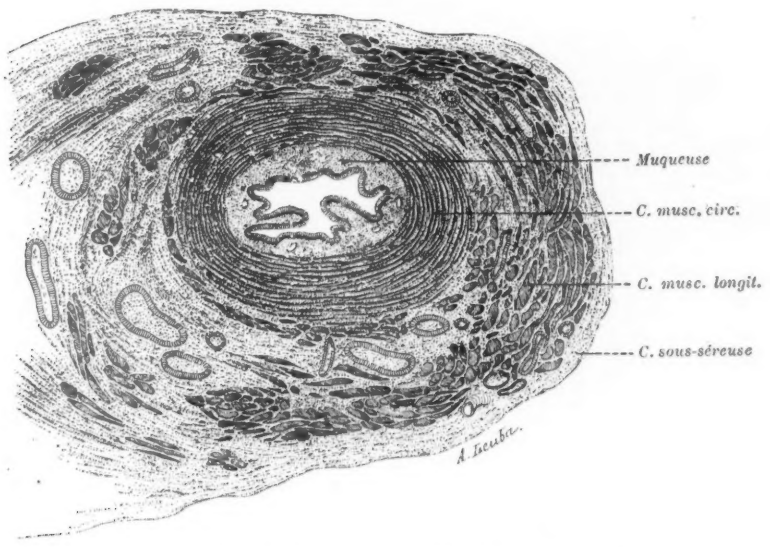

Fig. 3. Transverse section of the tube near the uterine orifice (Orthman).

Strictures produced at the uterine cornu call for certain preliminary considerations, anatomical and pathological.

ANATOMY

Testut states that the inner opening of the tube scarce permits the introduction of a boar's bristle. Poirier and Charpy say "the ostium uterinum measures about one millimeter in diameter and is impossible to catheterize in the living [Floeckinger's case excepted and accepted] and even difficult to see in the dead, and is often closed by very thin mucus" (Fig. 1).

"In the nullipara one sees in the incised organ that the intramural segment, analogous to the uterine cornu of animals, resembles a funnel (Fig. 1) opening toward the cavity of the uterus. The narrowest part of the tubal canal (which is the ostium uterinum in the multipara) is found in the nullipara some millimeters further and not exactly at the superolateral part of the cavity of the uterus" (Richard). While most of our sterilizing is done for the multipara, it will thus be seen that for the non-parous uterus a smaller tip and greater care are needed, lest we place the stricture too low and leave blood from menstruating membrane to back up behind it. Guyon's casts show the differences (Fig. 2).

"The mucous coat," says Testut, "lines the muscular coat of the tube and adheres to it entirely without a connective-tissue layer between. There is scant folding in the interstitial section. In the intervals of the folds the mucous membrane measures 0.1 mm. to 0.2 mm. in thickness" (Fig. 3).

Our deliberate inquiry has, however, chiefly or only to do with the mucosa of the cavity of the uterus at a point as far into the angle as we can penetrate with a blunted tip without force. To quote Testut further, "the mucous membrane of the body of the uterus adheres intimately to the muscular coat beneath it; but it is very friable and consequently alters easily. Its thickness at the middle of the uterus, where it attains its maximum, is 1 to 2 mm.; from there it diminishes gradually in passing toward the superior angles. At the level of the entrance of the tubes it is hardly 0.5 millimeter."

"The thickness of the walls of the uterus, elsewhere in the corpus averaging 10 to 15 mm., is at the opening of the tubes only 8 mm. (Sappey) . . . . The width of the transverse diameter is 25 mm. between the tubes.

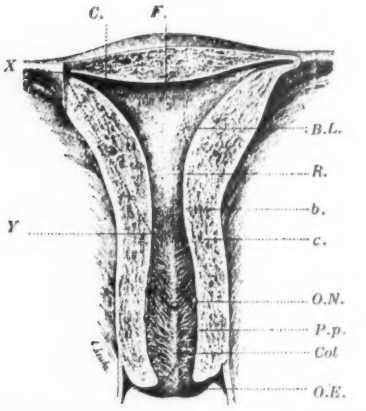

Fig. 4. Cavity of uterus of virgin, posterior surface natural size. *pp.* Palma plicatæ clearly defined, *O.N.*, Nabothian glands (Guyon, Rieffel).

. . . . The uterine cavity of the multipara has a triangular shape like that of the nullipara but less regular . . . . According to Guyon, Hageman, and Mauclaire this cavity becomes enlarged (or at least the uterine horns descend, in a sense, so that if from the extremity of the horns of the uterus one draws (in a virgin) a straight line to the internal os (Fig. 4, XY) one will have nearly the form of the cavity of the multipara (Fig. 5): the uterine horn has not disappeared but widened or enlarged."

CLOSURE OF THE INNER END OF THE TUBE BY DISEASE

All the authorities agree that in hydrosalpinx or pyosalpinx obliteration of the lumen of the tube at the uterine end practically does not occur (Albers, Reymond, Landau). Closure is produced only in a mechanical way, by kinking. Atresia (absence of any opening) by the shut-down of a scar (*narbige Einziehung*) or adhesion (*Verwachsung*) is rare (Fromme and Heynemann, Veit's *Handbuch*).

There is an ample literature well illustrated for the closure of the fimbriated ends of the tube, but only a paragraph or a sentence given by each writer concerning the pathology, macroscopic or microscopic, of the inner end of the tube. A reasonable search found no picture of a section of a sacto-salpinx that cut through fundus and interstitial and uterine

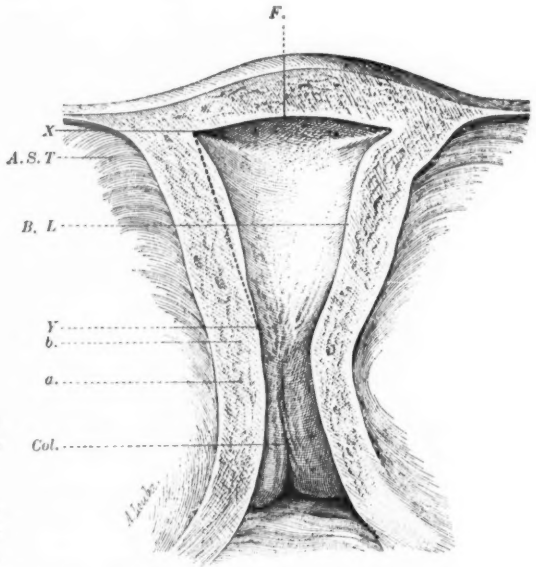

Fig. 5. Cavity of the uterus of a multipara; natural size. Triangular form of the body; folds of the tube radiating in the superolateral angles; double column of the palma plicatæ (Guyon).

portions of the tube and its sac. Our total find is one diagram of Reymond's that does not take in the cornu. Microscopic sections exhibit the kinked tube, where the lumen is shown two or three times in the same slide. In practice the pathologist's contention is borne out by authentic but most uncommon cases, beginning with Frank's in 1840, in which the tube empties its contents into the uterus. The anatomic proof was furnished by Rokitansky and Klob.

CLOSURE OF THE TUBE BY LIGATURE

The classic experiments are Fraenkel's, embracing 33 operations on 26 rabbits. The tubes of the higher mammals are very like the human, histologically. Those of the rabbit are 1 to 2 mm. thick. He found that notwithstanding favorably placed strands and tight ligatures one does not often succeed in interrupting the lumen of the canal of the tube. Whether with section or with ligature, tight or loose, thick or thin, of catgut, or silk, or rubber, atresias were accidental and rare. Forty per cent of the canals stood open into

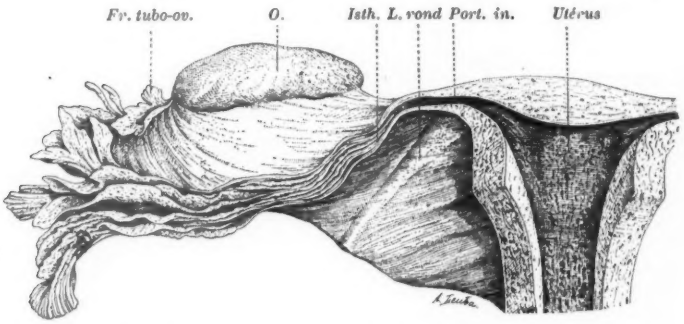

Fig. 6. Right tube cut open throughout its length in a multipara (Richard).

the peritoneal cavity, and a ligature could cut through and the canal repair itself. In two of the cases the cutting away of a section 1.5 cm. long resulted in a re-established channel. He was not able to use the hot wire to cauterize the lining because the caliber was too narrow. Ten to fifteen per cent of his ligated tubes ended in hydrosalpinx, though the ampulla was open. He counsels omission of a ligature on the cut end of the distal portion if section is done. For sterilization Fraenkel recommends removal of a wedge at the cornu and favors removal of the whole tube with the wedge. The reopening of the tube coincides with general operative experience in part, since, rather as curiosities, a small number of pregnancies have been reported after ligation or amputation of the tubes.

EXPERIMENTAL CLOSURE BY CAUTERY

Experiments upon animals to test cautery stricture are unsatisfactory because of the bicornate uterus, with the tube a continuation of the uterus, there being no cornu as it exists in the human uterus. Their uterine musculature is so thin, compared with the bulging thickness of the human uterine wall near the cornu that it is not possible to make adequate comparison. The only advantage in animal experimentation is that the abdomen can be opened and the action of the cautery observed through these thin-walled structures. One difficulty with observations on the ape consists in the high cost of all the larger monkeys. Therefore our preliminary studies will be mainly restricted to the application of this method to patients with reasonably symmetrical uteri which will subsequently require to be taken out for the hæmorrhages of the menopause; that is, the persistent bleeding of arteriosclerosis or chronic metritis which is not relieved by curetting. I made this test also with a small fibroid uterus, but on one side the cautery tip ran up beneath a submucous fibroid and lodged there (Fig. 7). The test cannot well be made in the operating room after curetting has been done because of the oozing but on such a menorrhagic uterus, in which one has failed with curetting, the experiment may harmlessly precede removal to train one for actual cases where it is indicated. In the office it should be done, for such practice, at some time a few weeks before hysterectomy, so that the scar would have been formed and could be studied in section and it should not be done at such a brief time preceding operation that suppuration is under way at the time of removal.

Is there danger of the *cautery tip puncturing* the uterine wall? In experiments with a newly killed animal it is seen that as far as the intestinal wall goes there is not a great deal of difference between ten seconds and twenty seconds application of the heat. If five seconds application of the tip at a given heat will result in an eschar involving the whole mucous membrane, then twenty-five seconds is needed to produce perforation of the entire intestinal wall. This field of double the necessary exposure gives us a wide margin of safety. Moreover one takes care

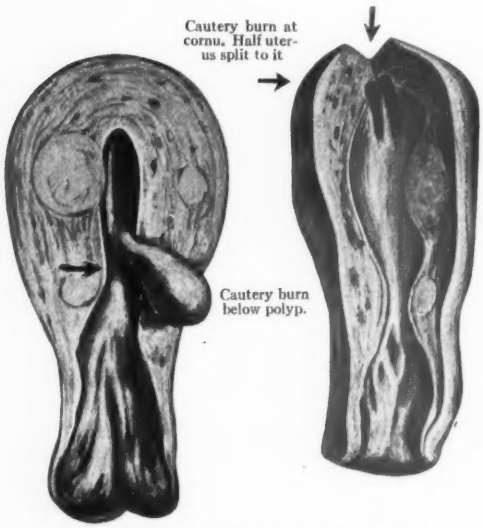

Fig. 7. Sketch of uterus in which the blunt or dome-tipped cautery-sound produced burns, preceding hysterectomy, as a demonstration of this method. Misapplied on one side—under polyp.

that no pressure is exerted in applying our heat and thus we further safeguard its application.

As shown by the researches of Hitchman and Adler, the mucous membrane of the uterine cavity is two or three times as thick during the six or seven days preceding the beginning of menstruation as during the resting stage. Therefore this is a time to be avoided. For three or four days after the cessation of menstruation, however, bleeding is so readily produced on contact that these days also should be avoided. The best time therefore will be from the seventh to the fourteenth day following the cessation of the flow.

CATHETERIZATION OF THE FALLOPIAN TUBES

W. Tyler Smith in 1849 speaks confidently of passing a fine whalebone guide through a silver directing tube which, fitting the curves of the cavity, leads the fishbone to the horn of the uterus and so beyond. "The fallopian angle of the uterine cavity is so acute, and the internal surface so smooth and dense in this situation that it is almost impossible for the whalebone fiber to miss the tube . . . . It is necessary to have two silver tubes or catheters, one for the left, the other for the right" with "the curve of the uterine sound . . . . and an additional lateral curve at the extremity, turning toward the fallopian tube . . . . not as large as the uterine sound . . . . The bougie is very flexible at the extremity." Further study of this abandoned procedure is worth undertaking (Fig. 8).

STRICTURE BY CHEMICAL ACTION

The attempt to treat diseases of the endometrium and hæmorrhage by strong corrosive agents brought out a considerable literature in both French and German. The ultimate sweeping condemnation of the severer methods has an important bearing on our particular problem. Such destruction of the lining of the uterus occurred that obliteration of the cavity resulted, in part or in whole; or vicious stenosis followed, shutting off parts of the uterus and blocking up menstrual flow or suppressing it entirely. The reports demonstrate the power and effectiveness of these agents, which, hurtful in excess and when applied to a large area, may well do the work we require if properly limited and controlled. For instance Rielander (*Veit's Handbuch*, 226) did four hysterectomies 15 to 30 hours after chemical intra-uterine treatment (iodine, colloidal silver, formalin). The mucous membrane after 30 per cent formalin in alcoholic solution was sloughing in 24 hours, and after 50 per cent formalin in watery solution necrosed throughout, where cauterized. Crayons of 50 per cent zinc chlorid in the uterus, or the stick of fused silver nitrate left hours in the cervix — even with its thick lining — have produced complete obliteration. Of course such severe and painful measures thus applied are to be condemned. They may even lead to threatening hæmorrhage, from deep sloughing, as in the cases of Duehrrsen and Duvelius. With these brief references to a large subject we pass on, merely drawing attention to the familiar partial closures of the vagina from cohesion of surfaces bared of their linings, and these in a canal subject to more motion than the uterine walls.

Froriep, in 1850, proposed a limitation of this chemical action in order thus to pro-

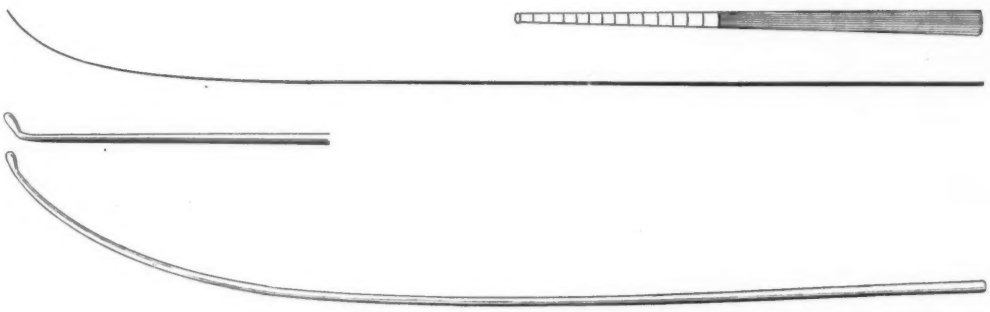

Fig. 8. Front and side views of the fallopian catheter. The first showing the uterovaginal curve; the second, the fallopian curve of the instrument. The other figures represent the whalebone bougie and the handle (scale unknown). (Tyler Smith.)

duce a limited slough and a stricture located in the tip of the horn of the uterus. He seems to have received little attention. The procedure consists herein: The speculum is introduced and "the conductor (Leitungsrohr) is passed through the os uteri up to the uterine opening of the tube and through this is pushed a sound tipped with nitrate of silver and so the circumference of the tubal opening is changed into a slough by deep cauterization." The same process is carried out on the other side, and "then the casting off of the two sloughs is watched."

"This casting off will take place (by analogy with cauterization of the bladder opening) in about 7 days, and there is the greatest possibility that, as no excretory flow keeps the way open, the complete adhesion (Verwachsung) has already occurred, as soon as the casting off of the slough has taken place. That the closure is perfect may be ascertained with sureness 8 days later by introducing the whalebone sound of Dr. Tyler Smith by which one may convince himself that the tubal lumen toward the uterus is passable. If this should be the case on one side, naturally the procedure must be repeated." He goes on to say that this cauterization is not dangerous, as it is the practice to produce such cauterizing with much deeper reaching injury to cure endometritis when the caustic agent must be applied through the speculum and when it is accomplished without consciousness on the part of the patient and many times without any marked reaction.

STRICTURE BY INTRA-UTERINE CAUTERY ELECTRODE

A method is submitted, simple and without danger, and heretofore only published by me in a discussion. It involves a moderate degree of gynecological dexterity and also some familiarity with the use of the electric cautery. It may be carried out in fifteen minutes in any office properly equipped.

The procedure consists in the production of a complete closure at the point where the fallopian tube enters the uterine cavity. The stricture is caused by scar shrinkage following the burn and the slough produced by the application of heat through a cautery tip the size of the point of the ordinary uterine sound on an instrument resembling a uterine sound, or by the use of the ordinary nasal electrode.

My evolution of this method has been as follows: Hunner has advocated the treatment of endotrachelitis by the use of the Paquelin tip. While simple and superficial involvements do best under silver salts or iodine, when one encounters a cervix chronically everted, eroded, and markedly granular, there is no method inducing such quick and permanent healing as the use of the heated wire. Take, for instance, the woman who has had one or two children and, as a result, has suffered considerable laceration of the cervix with subsequent outrolling and rawness. She desires other children. Meanwhile the cervix has to be put into order. If it is repaired or amputated subsequent

delivery will almost always tear it open again. Or there are cases in which the disease is on a sufficiently small area of the cervix so that, once healed, there would be no need of doing an inversion operation. The smallest sized tip that is used in the nose is applied in a point-puncture fashion or in longitudinal stripes, the burn going through the thickened mucous membrane. This may or may not have been preceded by the use of adrenalin novocaine applied to surfaces freed from all mucus. The method is a painful one without cocaine. One more successful use of this means in endotrachelitis I have developed; namely, in aggravated cervical catarrh. The cervical canal is solidly blocked with clear mucus, very tenacious and often large in quantity. In such cases one can spend several minutes in twisting strips of gauze into the canal before the half drachm of tenacious mucus has been entangled and is gradually withdrawn. Then we have a cavity which would hold the tip of the finger provided it could pass the narrowed external os. It had been my habit to treat these by scraping the gristly lining of this cervical canal with the small, sharp curette, which rasps as if on the back of Brussels carpet. If one fails under such conditions, the ordinary cautery wire tip of small size is laid along this area in stripes; or the tiny dome, its end the size of the ordinary uterine sound, is employed.

These matters have been developed in some detail because anyone who would carry out the method which I advocate in this paper would have an advantage in being accustomed to the use of the cautery under the above conditions, and would feel himself at home when this little dome or tip is slipped far out of sight up into the angle of the uterus. Previous experience shows just what heat will produce a given amount of slough.

DETAILS OF PROCEDURE

The steps are as follows: A suitable case is chosen. The patient has no submucous fibroid or cancer or any other disease which would necessitate a hysterectomy, or any disease which would necessitate opening the abdomen, for in either of these cases hysterectomy or ligation of the tube would be clearly indicated rather than this method. Lying on the table with clothing loosened and bladder empty, in the lateroprone posture, and the Sims speculum in place, with the perfect illumination of the head light, or the forehead mirror, in a darkened room, a single tenaculum seizes the anterior lip of the cervix and steadies it. The canal being clean and open, 5 to 10 minims of novocaine (10 per cent) in adrenalin solution are injected through a Skene pipette and held under pressure a few seconds. Ten minutes are allowed for anæsthesia. Then the canal is wiped with Churchill's tincture or pure carbolic acid. Next the ordinary uterine sound, with the ordinary curve, and surely sterile, is passed into the uterus and to the fundus. It turns gently sidewise to outline the cavity of the uterus and find the cornu, and an exact note is made of the distance. We will say from the external os this is 2.5 inches. A clear mental picture is made of each cornu and the distance apart of the two angles. The sound is withdrawn. The cautery sound (which is of the same size) is bent to conform in shape to the uterine sound and has its slide pushed up until there is exposed exactly 2.5 inches of the farther end. This sound bears on its tip a little spiral or dulled point of platinum wire which will become incandescent. The switch is thrown and the platinum wire heated up as a test that it is working. Then against the cervical mucous membrane, in plain sight, the platinum tip is placed. The current is turned on. A count is made of the number of seconds required to burn into the tissues a sufficient distance to bury the platinum wire. This will then be the correct time, under ordinary circumstances, for the cornu. If the cervical tissue is dense from chronic inflammation a part of the vaginal wall may furnish the control test. It will have been previously bleached with novocaine-adrenalin. Now the tip is allowed to cool and this sound is passed into the uterus and finds the cornu as previously determined. Then the current is turned on for the number of seconds that have been found necessary to produce the burying effect at the cervix, care being taken

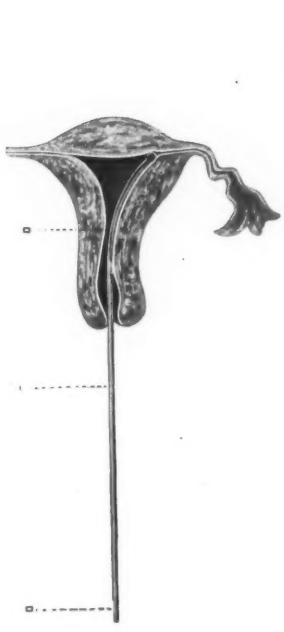

Fig. 9.

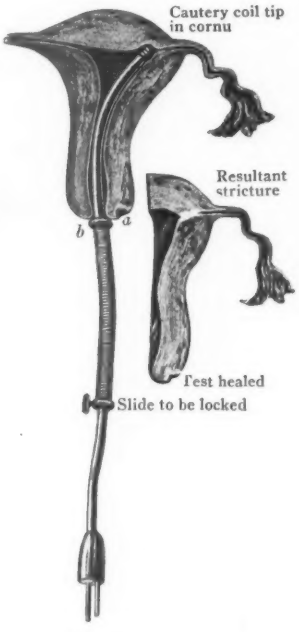

Fig. 10.

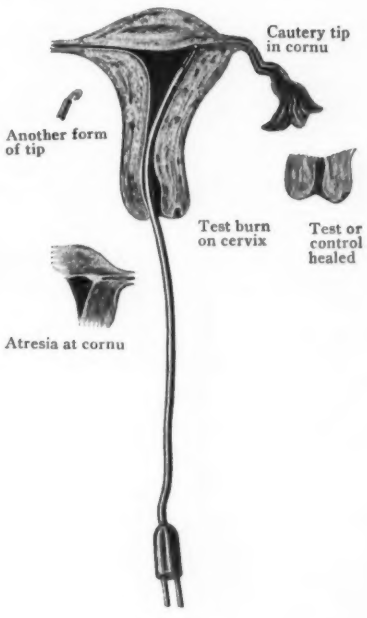

Fig. 11.

Fig. 9. Sterilization by chemical cauterization, showing metal or bent wood rod tipped with caustic. The rod may run in the catheter.

Fig. 10. Sterilization by cautery stricture with dome tip on uterine sound. This collar (*b*) prevents tip entering beyond previously determined depth. (*a*) Test cautery.

Fig. 11. Sterilization by cautery stricture with fine cautery electrode.

to exert no pressure more than is necessary to hold the cautery sound in place. The other cornu may be done at the same time or at a second session. The patient may lie down a bit or go home in some comfortable way and be quiet at home that afternoon and evening. If she has discomfort next day she should be quiet for that day and two or three thereafter. The reaction is usually no more than that of an ordinary intrauterine application. A little bloody discharge may occur then or some days later, and the next period may be a little uncomfortable. There occurs on the cervix a slough and then a clean granulating wound that within two or three weeks is healed over. The cervix condition gives a guide to what is going on inside. At the end of three or four months the presence of a stricture and the closure of the tube may be ascertained by the X-ray method of William H. Cary of Brooklyn.

Strict indications must be worked out for each case. This goes without saying. The presence of physical conditions — like extreme deformity of the pelvis, or of disease, such as chronic Bright's, or of disability, such as idiocy, epilepsy or confirmed insanity or of criminality — these are presupposed. The more difficult decisions are in the case of women apparently permanently neurasthenic from severe labors or who have had to have several pregnancies interrupted. In any case written consents of husband and wife (or of the parents of an idiot) and signed agreements of physician and specialist should safeguard this measure.

Objections. The objections to cautery stricture will probably lie in unskilled attempts. An insufficient cauterization will not produce atresia (complete closure). Adhesions of the uterine walls lower than the angle will do what the old chemical corrosives

did and may back up menstrual blood behind the spot acted on. Local hæmatometra or even hæmatosalpinx may result from such imperfect technique. By analogy with experimental ligatures of tubes on animals hydrosalpinx may follow this procedure even with tubes wide open at their flaring ends. Such hydrosalpinx has been of mild degree. The main trouble of course lies in the difficulty of knowing whether one has succeeded and whether assurance can be given so positively that the pair can omit contraceptive measures. Wherefore, until experience with removed uteri or freedom from pregnancy proves the procedure right we cannot be sure of it, unless, possibly, we can refine Tyler Smith's tubal catheter or perfect Cary's shadows.

In the case of defectives the simplicity of the procedure makes it worthy of trial even if we cannot guarantee all attempts.

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GENITAL ELEPHANTIASIS FOLLOWING EXTIRPATION OF INGUINAL GLANDS[1]

BY J. T. WINDELL, M.D., F.A.C.S., LOUISVILLE, KENTUCKY

TWO cases coming under my personal observation in which genital elephantiasis developed subsequent to bilateral inguinal adenectomy, constitute the principal incentive for the preparation of this paper. In one the hypertrophy promptly subsided under conservative treatment, in the other it has persisted for several years. The fact that genital elephantiasis may occasionally follow inguinal adenectomy suggests the advisability of greater conservatism in the surgery of this region. When one considers the reckless manner in which the groin has hitherto been invaded by the surgeon and the large number of patients subjected to operation for inguinal lesions, it is remarkable that genital œdema and elephantiasis have been relatively so infrequent.

A brief survey of inguinal topology seems necessary to a proper understanding of the pathology of this region. Textbooks and current literature contain meager information concerning the surgical anatomy of the groin, but the lymphatic distribution has been carefully studied during recent years. The latest classification limits the inguinal region

[1] Read before Southern Surgical and Gynecological Association, Cincinnati, December, 1915.

to Scarpa's triangle, yet this small area contains several important structures; viz., arteries, nerves, veins, lymphatic vessels, and glands. The older anatomists described the groin as the lower portion of the abdomen, between the lumbar region above and Poupart's ligament below, and between the hypogastrium and the inferior iliac spine. Thus, in addition to the structures already mentioned, the right groin contained the cæcum, the appendix, the ureter, and the spermatic vessels; the left the sigmoid flexure of the colon, the ureter, and the spermatic vessels.

The inguinal region is abundantly endowed with lymphatic structures, the superficial and deep glands, constituting one of the most important glandular centers of the body. The deeper glands are few in number and of minor consequence so far as this paper is concerned. The superficial glands are infinitely more important; they are variable (seven to twenty) in number and size, and occupy the area defined as Scarpa's triangle; i.e., limited above by Poupart's ligament, externally by the anterior inferior iliac spine, internally by the pubic spine, extending downward in triangular shape approximately two and a half inches.

The superficial inguinal glands are situated in the deeper layers of the superficial fascia, in close proximity to the superficial circumflex iliac and superficial external pubic arteries, the corresponding veins, the terminal portions of the internal saphenous vein, and the crural branch of the genitocrural nerve. A horizontal line drawn through the saphenous opening divides the superficial glands into two groups: (a) the superior, and (b) the inferior. A vertical line similarly placed separates these groups into (a) external, and (b) internal. A more elaborate classification would be: (a) the supero-external, (b) the supero-internal, (c) the infero-internal, (d) the infero-external, and (e) the central group of glands. However, such divisions, being purely arbitrary, are of interest only for the purpose of anatomic study.

The superficial inguinal glands receive the cutaneous lymphatics of the lower limb, the perineum, the scrotum, the penis, the anus, and the subumbilical portion of the abdominal wall. As the afferent penile and urethral branches discharge their contents through trunk vessels into the superficial glands, the frequency of infective lymphadenitis in this situation is not difficult to understand.

The pathology of genital elephantiasis is peculiar, in that irrespective of its cause, the resulting changes are invariably the same. Lymphangiectasis is a constant feature; enlarged lymphatic vessels are apparent everywhere in the involved area, from immediately below the epithelium to deep within the corium and subcutaneous tissues; they contain no erythrocytes but are found adjacent to the blood-vessels. Local obliterative endarteritis is commonly observed, and collections of round and so-called plasma cells are noted near the blood-vessels; cell proliferation and hypertrophy invariably involve both the superficial and deeper structures. Increase in fibrous tissue is the most prominent feature and constitutes the bulk of the enlargement; the process involves the skin, the blood-vessels, the lymphatics, also the nervous and muscular structures; the various layers of the skin become indistinguishable because of the enormous increase in fibrous tissue fascicles; the corium is thickened and indurated; the fascia and intermuscular septa are augmented and present evidence of fatty degeneration; section shows the hypertrophic tissue to be fibrous, lusterless, sclerotic, homogenous, and a lymph-like fluid exudes.

The fact that genital elephantiasis infrequently follows radical inguinal surgery renders its occurrence none the less unfortunate. In many instances the local pathology for the relief of which the operation is undertaken owes its origin to infection (Neisserian, tuberculous, syphilitic, streptococcic, etc.) with resulting lymphadenitis and obstruction. As a rule the obstruction is temporary, and if infiltration be not extensive, recovery ensues under conservative treatment. Even where the glandular enlargement and infiltration are considerable, surgical extirpation is seldom justifiable; obstruction from pressure of the enlarged glands usually disappears with restoration of the circulation, and elephantiasis rarely follows

where conservative measures are employed. It must be remembered that genital elephantiasis may be produced by any pathology which markedly interferes with the inguinal lymphatic circulation, even without previous infection; e.g., pressure from adjacent neoplasms, partial obliteration of the lymphatic vessels from external trauma, mechanical obstruction from any cause. However, not all external traumatisms, surgical operations, and pathologic lesions of the groin which interfere with lymphatic circulation are followed by genital elephantiasis; in fact, experience has demonstrated that it is an exceedingly infrequent sequel. This is further emphasized by the fact that in experiments upon animals, no one has yet been able to produce genital elephantiasis by resection of the inguinal glands.

The clinical history sometimes suggests an infection entirely independent of operative or mechanical factors which might interfere with the circulation of lymph; in such instances repeated chills, fever, swelling, itching, redness, etc., noted as concomitant manifestations, indicate that an erysipelatous infection ("recurrent erysipelatous lymphangitis") may be the determining causative factor. "It is not unlikely that the obstruction is secondary to the infection in many cases, and that the recurring cellulitis is to a large degree responsible for the hyperplasia of tissue constituting the main element in these singular cases; in other instances, the infection occurs following operations which interrupt the continuity of the lymph channels" (LeCount).

It is the contention of Shattuck and others that the essential characteristics of acquired elephantiasis in any situation are: (a) lymphangiectasis, (b) hyperplasia of connective tissue, and (c) chronic œdema. The interrelation of these phenomena, however, in the production of genital elephantiasis is not clear. The tissue changes may be attributed to the interaction of lymph stasis and inflammation; stasis always occurs early and persists; inflammation may precede or follow stasis, or it may not be manifest at any stage of the pathology. When present it may be acute or chronic, and is generally traceable to bacterial invasion. While either chronic stasis or inflammation from any cause may predispose to elephantiasis, even when occurring together, hypertrophy does not always result. Congenital weakness or anomalies of the lymphatics may play an essential part in the production of elephantiasis.

The researches of Bayer on the pathology of genital elephantiasis following inguinal adenectomy direct renewed attention to the importance of greater conservatism in the surgery of this region, i.e., of preserving the periglandular and areolar tissues, as these structures contain an extensive system of lymph-spaces from which regeneration of the glands and vessels quite frequently occurs. If the periglandular fatty tissue is removed or otherwise destroyed, regeneration is impossible and a condition favorable to the development of genital elephantiasis exists. "These conclusions are all the more important because when once genital elephantiasis is established, nothing can be done for its relief, except wide excision which is unsatisfactory. As a very unpleasant pitfall in the way of surgeons operating in this region, this complication deserves very careful consideration."

Unfortunately there has yet been devised no satisfactory method of treating genital elephantiasis which is applicable to all cases. Where the hypertrophy is moderate, however, as occurred in one of my cases, conservative local treatment by the application of a suitable suspensory apparatus will sometimes be of benefit.[1] The injection of fibrolysin (Castellani) has proved disappointing, as have also the methods devised by Carnochan (ligation) and Handley (lymphangioplasty). Radical operative intervention, contemplating extirpation of the elephantiasic tissue with preservation of functionating genital organs, will usually be futile. In the majority of instances the hypertrophy gradually progresses as in the endemic type, and amputation of the genital organs may become necessary to relieve the patient of the tremendous weight.

[1] The scope of this paper precludes consideration of endemic elephantiasis due to lymphatic obstruction from systemic invasion by the filaria sanguinis hominis, in which structures other than the genital organs are usually implicated in the pathology. So far as can be ascertained the filaria have not been demonstrated present in any case of genital elephantiasis following inguinal adenectomy.

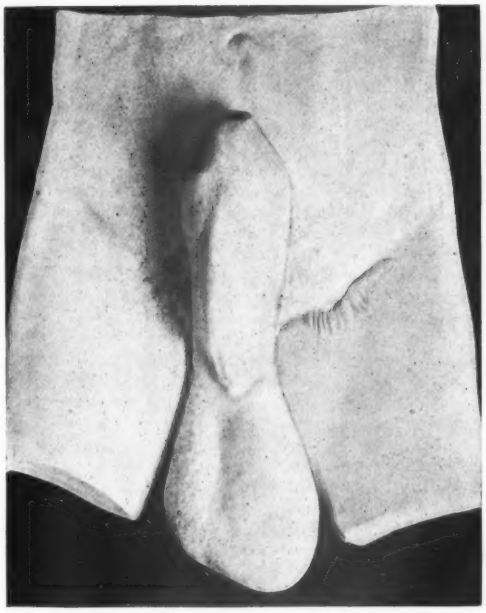

Fig. 1. Photographs of a plaster cast of Case 1.

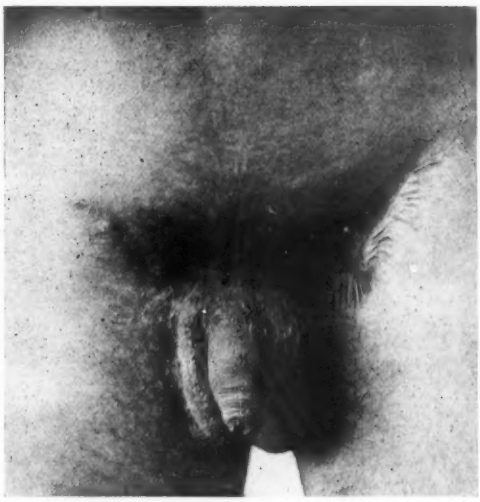

Fig. 2. Inguinal cicatrices in Case 2.

PERSONAL OBSERVATIONS

CASE 1. Mr. N., age 37, single; date of first observation, June 25, 1911. The patient at that time presented an enormous elephantiasic enlargement of the entire scrotum and penis. The scrotum measured sixteen inches in circumference; the penis (at its largest part) was twelve inches in circumference, and eleven inches in length. He gave the history of having contracted syphilis in 1903.[1]

Two surgical operations had been performed for the removal of enlarged and infiltrated inguinal glands, one in 1905, the other in 1909, but for what character of pathology, the patient did not know. Dense fibrous tissue scars, adherent to the underlying structures, were present in both inguinal regions. The scar-tissue was more abundant in the left groin, which probably explained the greater scrotal enlargement present on the corresponding side. The patient stated that he had been under antisyphilitic treatment continuously since 1903, and that thickening of the penile and scrotal tissues was first noted early in 1910.

Local treatment consisted of an appropriate suspensory apparatus and antiseptic dressings. At no time while the patient was under my care was there any acute inflammation of the penile tissues; but the scrotum, owing to the continuous exudation of lymph from its surface, at times became infected and exhibited evidence of acute inflammation, which was relieved by suitable antiseptic applications.

On July 10, 1911, the Wassermann reaction was found to be 3+. For several months the patient was treated by mercury in its various preparations and modes of administration, and later by salvarsan. The man suffered from periodic attacks of intense pain apparently involving the entire body and lasting sometimes for two or three days. These attacks were relieved by the administration of iodide of potassium of which he was able to take very large doses; i.e., half an ounce of the saturated solution during twenty four hours.

November 11, 1913, the Wassermann reaction was 2+. Twelve days after the administration of salvarsan, December 7, 1913, there occurred considerable swelling, pain, and redness of the left arm around the elbow-joint, which was sufficiently severe to cause the patient to remain in bed and require the constant attention of a trained nurse. Such manifestations following the injection of salvarsan must be exceptional, and are difficult of explanation except upon the hypothesis that there existed a local lymphatic or vascular abnormality preventing prompt elimination of the drug. The symptoms subsided within six weeks, and there was no similar recurrence following subsequent salvarsan injections.

Salvarsan was again administered on March 29, April 14, and May 10, 1914. On September 2, 1914, the Wassermann reaction was 1+. There has been

[1] Several instances of moderate genital elephantiasis have been observed accompanying Hunterian chancre, probably due to the production of an exudate in the lymphatic glands by the action of the spirochætæ pallidæ, or from occlusion of the lumen of the lymphatic vessels by the organisms themselves. The hypertrophy soon subsided under active anti-syphilitic treatment.

no reduction in the genital hypertrophy; the supportive bandage has been continued. The patient is in excellent physical health. At my suggestion he has consulted several eminent authorities, some of whom are fellows of this association, and all have agreed that surgery is not indicated.

CASE 2. Mr. B., age thirty, single. On September 10, 1912, three months after bilateral inguinal adenectomy for enlarged and suppurating glands probably of tubercular origin, the patient presented an immense hypertrophy of the penis. It was unaccompanied by redness or pain, and the scrotal tissues were apparently uninvolved. Several deep scars were present in each groin from the previous operations.

Having in mind the unfortunate case just reported it was thought this was another of similar character, and the diagnosis was made accordingly. An appropriate suspensory apparatus was applied, and the patient requested to report three days later for further observation and treatment. However, he failed to return, and from information subsequently received, it appears that the penile hypertrophy subsided within two or three months.

COLLECTED CASES

Quite recently Hill reported a case of elephantiasic fever followed by genital elephantiasis in a patient aged 43, developing six years after bilateral inguinal adenectomy. The penis measured nine inches, and the scrotum twenty inches, in circumference. The author states that the hypertrophied tissue was removed by extensive resection, the testes and penis being preserved, and the resulting anatomic defects overcome by plastic surgery. Perpendicular incisions extended from the abdominal rings downward, the testes and spermatic cords being dissected from the scrotum "where they were embedded in a mass of lax, blubbery, dropsical areolar tissue"; then the "sacred highway so essential to the perpetuity of the race" was liberated, and practically the entire scrotum removed. The testes were covered with adjacent skin, in the loosening of which the deep muscular lymph-spaces were extensively exposed. Upon the dorsal surface the incision extended the entire length of the penis which was freed of its covering "as you would a banana." After extensive dissection the pubic skin was sutured to the mucosa of the glans, practically covering the organ. The wounds readily healed, "and although the organ is whiskered and rather unsightly, it retains its reach when in action and the owner says it is more than satisfactory." The elephantiasic fever recurred after the patient left the hospital, which was relieved by the administration of polyvalent antistreptococcic serum according to the recommendation of Matas. The patient recovered and has since remained well.

Hamann encountered four cases of genital elephantiasis following extirpation of the inguinal glands, one of which is described in detail occurring in a fema'e from whom the glands were removed during dissection of the sac of a femoral hernia. Six weeks after operation there occurred chills and fever accompanied by swelling and redness of the labium majus of the corresponding side, and during the succeeding four months seven or eight similar attacks were experienced, during each of which the labial induration increased. Diagnosis: lymphangitis accompanied by lymphatic œdema due to interference with the lymph circulation, produced by removal of the fatty tissues and lymphatic glands and the succeeding cicatricial contraction. "There is small room for doubt that in cases of this kind infection added to the interruption of the lymph current bring about the hyperplasia of the subcutaneous tissues constituting elephantiasis."

Three cases of genital elephantiasis following inguinal adenectomy observed by Riedel, induced him to abandon the operation and substitute therefor incision and curettment. Bush (*Lancet*) records two similar cases, and another is reported by Baker. In his recent work on urology, Guiteras cites four interesting personally observed cases of scrotal œdema. In three the œdema developed subsequent to radical removal of the inguinal glands; in the other it was apparently due to tuberculous epididymitis and subsided after orchidectomy.

Rubinstein observed a case of scrotal elephantiasis without immediate venereal precedent in a male of 23, who immediately after lifting a heavy weight noticed swelling of both sides of the scrotum. A week later the scrotum was four times its normal size, the penis and testes being uninvolved. Two years previously the right inguinal glands had been removed on account of acute inflammation. The author remarks that a few similar cases have been recorded, produced by sudden strain in persons suffering from chronic Neisserian infection, upon whom bilateral inguinal adenectomy had been previously performed.

The following two cases are included in the series, although the elephantiasic enlargement did not follow inguinal adenectomy.

Campbell observed scrotal elephantiasis due to truss-pressure in a male, weighing two hundred and twenty five pounds. For twenty-five and twelve years respectively, he had worn a single and then a double truss because of inguinal herniæ. The prolonged pressure where the scrotal lymphatics empty into the inguinal glands evidently produced obstruction. The author says when a truss is worn upon both sides compensatory lymphatic circulation is prevented.

In a case recorded by De L. Terrores genital elephantiasis owed its origin to the simple operation of posthectomy. A boy of eight years had phimosis with preputial excrescences accompanied by anasarca. Complete relief followed circumcision and he remained well for three years, when lymphatic varices were noted in the inguinal regions and about the genitalia. A few months later he developed

typical elephantiasis of the left lower extremity, the external genitals, and a semi-lunar zone of the lower abdomen, with slight involvement of right foot.

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PSEUDOMYXOMATOUS CYSTS OF THE APPENDIX AND RUPTURED PSEUDOMUCINOUS OVARIAN CYST[1]

BY FRED WARREN BAILEY, B.S., M.D., F.A.C.S., ST. LOUIS

WITHIN the past few years, there has been recorded in medical literature a number of cases of cystic tumors of the appendix and ovary, pseudomucinous in character. Without doubt many such tumors have been removed and destroyed, unrecognized. As near as can be determined, less than 100 such cases have been accurately described; and as there still exists some doubt as to etiology, and considerable difficulty as to diagnosis, the addition of case reports, though not in themselves enlightening, may stimulate instructive discussion.

CASE 1. E. B., St. Louis, Mo., male, age 25, electrician.

Family history, negative. *Personal history.* Usual diseases of childhood. Health normal in every respect until November, 1913, when at the age of 24 he developed acute appendicitis.

An operation performed within a few days was followed by slow convalescence. A sinus at the site of incision persisted for several weeks. It finally healed and the patient returned to his work. Pain in right inguinal region continued with frequent exacerbations and reappearance of the sinus discharge at intervals. Constipation, anorexia, and post-prandial nausea combined to reduce his weight and vitality and he applied for surgical attention.

Physical examination. Fairly well nourished man, with right rectus tonicity and tenderness on pressure over the entire right side of the abdomen as high as costal arch, particularly severe over scar, where blind pocket of pus was preparing to escape.

Operation, December 5, 1914, at St. John's Hospital.

The sinus was opened and a seropurulent exudate released. The exudate contained several flakes of gelatinous-appearing material. The abdomen was opened and a large omental tumor enclosing the cæcum presented. Upon removing the omental sac, the colon was found constricted at three points by strong fibrous bands which radiated mesially from the right parietal wall across the cæcum and ascending colon to disappear in a Jackson's veil on its inner surface.

When lifted, the cæcum at its lower point presented a tumor the size of the distal phalanx of the thumb; traced up, postcæcally, this proved to be a large appendix, distorted, and doubled upon itself, and fixed by an exceptionally strong fibrous fold which crossed and constricted it just proximal to the distended tip. The bed in which the appendix rested was filled with a gelatinous substance to the amount of 2 ounces, and the distal loop of ileum which was attached to the appendix tip was coated over with this same material, all of which came away readily upon a saline sponge. The appendix was released and removed, the omental sac was resected, and the cavity gently but thoroughly sponged free of its contents and treated with 3 per cent iodine. The sinus was then dissected and the wound closed without drainage. The patient left the hospital on the fifteenth day and since recovery has enjoyed perfect health (over one year).

Report of Pathologist (Dr. George Ives). *Gross description.* The appendix is 6.3 cm. long; its diameter near the distal end is 1.3 cm., and near the proximal end, 1 cm. On the side of the mesenteriole is a smooth-walled tumor-like mass projecting from the appendix; it projects between the layers of the mesenteriole. The shape of the portion of the tumor exposed to view is hemispherical. The wall of the tumor is tense, but fluctuation is elicited. The tissue of the appendix adjacent to the tumor appears gelatinous.

Upon dissection, it was found that the so-called tumor is a cyst filled with gelatinous material. The lumen of the appendix is obliterated excepting

[1] Read before the Southern Surgical and Gynecological Association Cincinnati, December 13-15, 1915.

for about 1 cm. near the tip. The patent portion of the lumen communicates by a narrow opening with the cyst.

Microscopic. The muscular coats are thickened. The lumen is displaced by fibrous connective tissue, an abundance of fat, distended capillaries and areas of round-celled infiltration. No lymphoid tissue is observed. The lining of the cyst consists of mucous membrane similar to that of the appendix. The lining cells of the former, however, are markedly flattened.

Diagnosis. Chronic appendicitis and pseudomyxomatous cyst of the appendix.

The primary operation, conducted by a very competent surgeon, evidently was limited to drainage of the abscess and disclosed no sign of pseudomucinous exudate; a mild type of chronic appendicitis, as the history indicates, followed this operation, and temperature, pain and increasing activity of the sinus denoted an acute exacerbation.

It would be interesting indeed to have undeniable evidence that the cyst represented in Fig. 1 had formed during the interval between the two operations. The nature of the sinus discharge, the contents of the periappendicular pocket, the local pseudomyxoma peritonei and the pathologist's findings, all indicate that the cyst was actively discharging its contents.

Recently published articles by Castle (1), Phemister (2), and E. G. Lewis (3) have admirably presented the present-day knowledge of pseudomucinous cysts, and a repetition of the symptoms, etiology, and pathology would be superfluous. There is no record of a preoperative diagnosis having been made.

The process of pseudomucinous cyst formation of the appendix is evidently slow. Two essential conditions are:

1. Gradual obliteration of a portion of the mucous tract by some agent.

2. Sterilization of the mucous lined tract distal to the obstruction.

The experiments conducted by Phemister and Dean Lewis, as well as our own observations, prove rather conclusively that any sudden blocking of the appendicular canal, even where care has been taken to avoid circulatory interference, results in gangrenous appendicitis.

The attempt to produce such cysts artificially will naturally fail until we can simulate in our experiments the course followed by nature in the development of appendicitis obliterans, wherein the process is so slow that drainage into the cæcum is not obstructed until the bacterial contents of the lumen are inactive.

While, theoretically, such a condition would be ideal for the formation of pseudomyxomatous cysts, we know the origin is not always so serene. In Case 1 of this report there existed, distal to the cyst, 1 cm. of non-obliterated mucosa and a section of acutely inflamed mucosa between it and the valve of Gerlach. Fowler (4) reports a case with a cystic dilatation of the proximal end of the appendix. There is no doubt but that such cysts may develop in an appendix, gallbladder, or intestinal diverticulum that is subject to chronic inflammatory changes, and it is also likely, as suggested by Phemister, that chronic hydrops or empyema of the appendix resulting from a proximal obliteration may become sterile and displaced by the altered secretion and a pseudomucinous cyst result. Under normal conditions the secretion from the mucosa of the appendix is identical with that of the cæcal mucosa, but the degeneration incident to the senile change which takes place in the isolated section, and the mucosal atrophy resulting from retention cyst pressure naturally alters the secretions, and the final contribution of the cell is pseudomucin.

Eden (5), Wilson (6), Rathe (7), and the writer each report a case of pseudomyxomatous appendix complicated by an ovarian cyst of large size. In all four cases, there had been a rupture of the ovarian cyst with resulting pseudomyxomatous peritonei.

A report of the author's case follows:

Case 2. Mrs. Mary E., Carrollton, Illinois, age 52, multipara.

Family history, negative. *Personal history.* Gradual enlargement of the abdomen was noticed two years ago, with increasing bladder irritation and severe attacks of nausea which were controlled by relieving the obstinate constipation. Several weeks before coming to St. John's Hospital she suffered an acute pain in the pelvis. This was followed by general abdominal tenderness and her state of health declined rapidly until the present time.

Physical examination. The patient is poorly nourished; appears to be 60 years of age. The skin is sallow and lax, indicating considerable loss of flesh. Temperature and pulse normal. Heart,

Fig. 1. Specimen removed from Case 1.

lungs, blood, and urine examinations negative. Contour of abdomen, normal except in right lower quadrant where a large inguinal hernia was present, and in left lower quadrant where a symmetrical enlargement extended across the median line. This was palpable as a softly resisting mass, regular in outline and evidently directed into the left pelvis. There were no distinctly tender points over the abdomen except at McBurney's point, where a thickened mass the size of an orange could be palpated.

Vaginal examination. Relaxed outlet from old perineal tear. Bilateral laceration of cervix. Uterus normal size and freely movable, not attached to mass in left pelvic region. Cul-de-sac of Douglas filled with mass of doughy consistence. Right adnexa not palpable. Rectal examination, negative.

Operation. June 12, 1915. Ether anæsthesia, cervix and perineum repaired.

Median incision revealed fundus of large tumor, leading down to site of left ovary. Posterior surface nodular but symmetrical, anterior surface broken just above its broad ligament attachment by a tear which admitted three fingers. The tumor was delivered quickly, and with the left tube excised. The uterus and right adnexa were normal. The fluid contents of the tumor could easily, by light manipulation, be expelled through the rent in the sac, and had soiled the entire peritoneal cavity. Besides the contents of the tumor, at least one liter was removed by hand from the pelvis and as much more by saline irrigation.

The small and large intestines, omentum, stomach, gall-bladder, and liver were covered with a glary mucilaginous material of varying thickness, and that portion of the intestines resident in the lower half was agglutinated, and could be lifted from the pelvis *en masse*. These intestinal coils were gently separated, to enable the saline to reach all parts of the cavity. On some loops of ileum, large masses the size of a pecan had attached themselves, but readily washed away. After persistent irrigation and gentle manipulation, the entire cavity was well cleansed, but the glary coating on the visceral peritoneum could not be removed without severe trauma.

The cæcum was elevated and an interesting appendix (Fig. 2) removed. After noting that it was cystic, care was taken to observe that there was at the time no evidence of an active exudate from its

Fig. 2. Specimen removed from Case 2.

lumen into the peritoneal cavity. There being no intra-abdominal complications at the hernial site, the abdomen was closed without drainage, leaving within about one liter of physiological saline.

The patient was sitting up in bed on the seventh day, and on the tenth day, under local anæsthesia, the hernia was repaired. The hernial sac had a capacity of about 40 ccm. and was entirely filled with pseudomucin, undisturbed by the abdominal irrigation.

She went home on July 11, just thirty days from the date of entry.

Pathological Report, Dr. Ives. *Gross description.* The specimen is a large appendix, 7 cm. long, in diameter fairly uniform. The greatest diameter is near the distal end where the measurement is 2.5 cm. The least diameter is near the center where the measurement is 2 cm. The wall of the appendix is very thin, translucent, smooth and tense. Fluctuation is easily elicited. There is a small mass composed of gelatinous material attached to the surface near the tip. A platinum wire which was inserted into this mass passed into the lumen without resistance. This latter observation indicates that the wall had ruptured and that there had been an escape of contents.

At the proximal end the appendix is constricted. Upon dissection it was determined that the lumen at this point was displaced by what appears to be dense fibrous tissue. The appendix is distended with gelatinous material. The latter varies somewhat in its appearance. Part of it is nearly transparent and part of it has a grayish appearance, due to a fine network.

The microscopical examination differs in no way from Case I.

Diagnosis. Ruptured pseudomucinous cyst of the appendix.

The second specimen, an ovarian cyst, shows a tumor apparently derived from an ovary. As some of the larger cysts had been ruptured and the contents had escaped, the exact dimensions of the tumor could not be determined, but its size was apparently about that of a man's head. The larger

portion of the tumor is made up of a few large cysts, but there are many small cysts, some of which are minute.

The surface of the tumor is smooth in parts and in other parts irregular. The latter conditioni s due to variations in the thickness of the fibrous tissue and to the presence of small cysts. The cyst wall is thin and the internal surface has practically the same appearance as the surface of the tumor.

The cysts contain a clear, fairly thick, pale yellowish, gelatinous material. A small portion of the tumor consists of gelatinous material in a meshwork of fibrous tissue without cyst formation.

A fallopian tube was removed with the tumor. This is normal in size. A portion of the peritoneum covering the tube and in its vicinity is coated with gelatinous material.

Diagnosis. Cystadenoma pseudomyxatosum and pseudomyxomatous peritonitis.

Interesting features in this case are the evidently primary involvement of both ovary (left) and appendix; the symptomless rupture of the ovarian cyst, and the complete dissemination over the peritoneal cavity and its contents following this liberation of pseudomucin. The fact that the patient still continues to improve in health, after six months' time, encourages one to hope that with the removal of the primary feeding foci, Nature will, by the aid of a versatile peritoneum, care for the remainder.

Unfortunately, the danger of malignancy is far greater in pseudomyxomata peritonei of ovarian origin than from a cyst of the appendix. A determination of this distinction is beyond the intent of this report.

Enlightenment on the method of growth of pseudomyxomatous cysts, and so-called colloid ovarian cysts before rupture and after its departure from the mother-cyst and attachment to the peritoneal surface, would be a valuable contribution.

Is it due to proliferating epithelial cells, as found in colloid ovarian tumors, or is there possibly some organism to account for the growth that continues after dissemination?

From a case in the service of Drs. Brown and Engelbach at St. John's Hospital, the following observation was furnished by Dr. Ives:

"The specimen had been removed from a case of pseudomucinous peritonitis. Cultures were made from several of the tumor-like masses by spreading the gelatinous material over the surface of slant glucose-agar and Loeffler's blood serum. In all of several tubes, a pure culture of yeast was obtained. The organisms occurred singly and united, several in a group. They were oval in shape. There were no thread forms as produced by the organism of blastomycosis on artificial media.

"The growth on agar spread over the surface; it had a dry appearance. The organism was anaerobic and fermented glucose with the production of gas."

Curtis (8) also cites a case in which the yeast-cell was observed in a pseudomucinous cyst of the appendix. There is no proof that the presence of yeast-cells in these two cases was not purely accidental, but the demonstration justified a more careful observation of such cysts in the future.

Ruptured ovarian cysts of whatever character are not without an element of serious danger, for in each such case there lies a potential malignancy. There is no record, to my knowledge, of true malignancy following a pseudomucinous cyst of the appendix; but by the plastic peritonitis and mechanical interference which follows such an extravasation, equally dangerous conditions may develop.

An early diagnosis would be of prime importance were it practical. Unless the disease has advanced to a stage where ascitic fluid can be drawn and pseudomucin found, an accurate diagnosis is hardly probable, for the symptoms differ in no way from those present in chronic appendicitis or ovarian tumor. Here again is demonstrated the value of early exploration in all obscure abdominal conditions, the natural result of a fair broad-minded co-operation between the internist and the surgeon.

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DEPARTMENT OF TECHNIQUE

DIATHERMY IN MALIGNANT TUMORS OF THE BLADDER

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IN late years the high-frequency current has been introduced into surgery for the destruction of tissue. The technique as first employed consisted in the application of the current by means of a suitable electrode so that the high-frequency sparks would be directed upon the surface of a tumor or upon the fresh wound after the excision of the growth. With this original arrangement the high-frequency sparks were directed upon the object of the treatment often from a distance of eight to fifteen centimeters. This process, termed fulguration, did not prove very satisfactory, because the sparks generated by the extremely high tension could not be controlled accurately but would fly in all directions so that their destructive effect could not be accurately limited to the desired region. This fault now has been overcome by the use of a spark of lower tension applied with a pointed electrode. Thus the dissemination of the sparks is reduced to a smaller and safer area, the object to be treated may be very closely approached, and the operator may confine the passage of the sparks to the desired area exclusively. For instance, if a suitable electrode needle is passed closely alongside of the surface of a tumor, the tissues will be separated as if cut with a knife, but with the difference that this electric splitting is bloodless.

At first a uni-polar apparatus was used. Later it was found more convenient to complete the secondary circuit oscillations by using the two polar electrodes. This arrangement may again be two fold. Either one of the electrodes may be of a rather large size and applied as the indifferent electrode to any part of the body, while the other, the smaller electrode, is used directly for the operation proper. By the second method, the electrodes, both of small size, are used for the operation, the size of each electrode being in reverse proportion to its intended active influence on the tissue. This latter arrangement of the high-frequency current leads to a still further development in its application in tumors. While the usefulness of an active pointed electrode is confined to cauterization of the pathological tissue or to its bloodless excision, the application of two active disc-shaped electrodes permits of the complete coagulation of tumor masses at any desired depth and to any extent planned. This is accomplished by placing the electrodes opposite to one another at a variable distance, sometimes at various diameters of the growth.

The apparatus employed in the generation of the high-frequency current must not alone be sufficiently powerful, but must also be equipped in such a manner that very gradual increase and decrease of the current with instruments of exact control and measurement is possible. Obviously one always starts with the smaller amount of current and amperage effective to avoid cauterization or coagulation where not required.

When coagulation of tumor tissue is intended, the current will be strengthened or weakened according to the lengths of the various diameters of the tumor, at the ends of which the electrodes are placed. Furthermore, the coagulation process calls for a gradually increasing current, because tissues already mortified offer a greater resistance than the untouched. Consequently as the process of the coagulation starts from the periphery a progressively increasing current will become necessary to produce the coagulation effect in the central portions of the tumor mass. It is well to mention that all the electrodes used for coagulation must be tested as to their field of coagulation power under a certain pressure so that the operator always has a clear conception of how far the coagulation will extend from the electrodes into the tissues. This testing is done before the operation on a piece of raw meat. All the operations under high-frequency current must be done under intense local or general anæsthesia because the action of the current on the living tissue is exceedingly painful.

In operating for malignant tumors of the bladder it is expedient to have both electrodes inside of the viscus in close proximity to the tumor. The choice of the various electrodes is determined by the purpose to be fulfilled. In dealing with a rather hard sessile tumor that extends into the

Fig. 1. Drawing showing method of removal of hard sessile tumors.

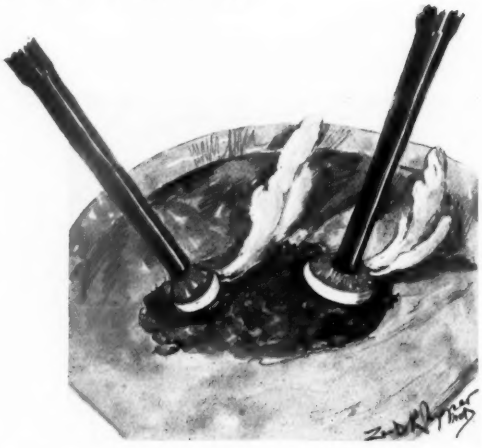


Fig. 2. Showing application of two disc-shaped electrodes in producing coagulation of infiltrated base.

bladder practically dividing the viscus into halves, the first step will be to remove the free bulk of the growth, the line of separation being chosen as close to the base as is feasible. This is accomplished by applying a larger electrode to one side of the tumor, while the excision is done with the Forest needle (Fig. 1).

The larger electrode will remain inert while the point of the needle is held at a distance of about half a centimeter from the surface of the tumor. In this way an arc-light is produced emanating from the needlepoint and running to the tumor and its mass is divided bloodlessly. The line of amputation gives a field for the thorough coagulation of the infiltrated base, which is accomplished by the application of two disc-shaped electrodes (Fig. 2).

Fig. 3. Showing removal of papillomatous growth by two knife-shaped electrodes.

If the growth be of a papillomatous character then it is removed by means of two knife-shaped electrodes. This procedure is simply an intense fulguration (Fig. 3). Following this the base is again thoroughly coagulated by the application of the disc-shaped electrodes. A successful operation is characterized by the fact that the area of interference will present a leathery appearance without any bleeding points. It is obvious that all these manipulations necessitate a suprapubic opening of the bladder. The length of this incision is determined by the size and location of the tumor, which will outline the extent of the necessary exposure. The clearance of the field for operation is accomplished by the insertion of broad retractors, which to great advantage should be made of wood or fibre. If the insulated handles of the electrodes are of sufficient length metal retractors may be employed, only under such circumstances must one avoid bringing the working ends of the electrodes in contact with the retractors.

The operation on tumors involving the prostate is very much facilitated by the insertion into the rectum of a Barnes bag that is inflated before the operation begins. In this way the trigonum is made easily accessible.

Resections of the vertex of the bladder for tumors should be done with the Forest needle.

All these diathermic operations are followed by the regular application of mesothorium through the suprapubic opening, and after the closure, if deemed necessary, the mesothorium is applied to the area to be rayed by passing the container through the urethra into the bladder.

A SIMPLE TECHNIQUE FOR RESECTION OF THE PROLAPSED RECTUM

By G. W. BROCK, M.D., Atlanta, Ill.

MIKULICZ, Treves, and others have regarded simple amputation of the prolapsed rectum the best resource in many cases. The technique below is a modification of that of Mikulicz, which is briefly as follows:

Grasp the prolapsed parts with gauze and cut across the front of the mass a finger's breadth or so below the anal margin. Cautiously open the peritoneal cavity and return any pelvic viscera that may be present in the rectovesical pouch. The clean peritoneal surface is approximated using a continuous stitch, suturing the inner cut edge of the outer gut to the outer wall of the inner. Carry the incision entirely around the prolapsed outer tube, and resume the continuous stitch already used in closing the peritoneal cavity. Now amputate the mass by cutting the inner tube off at the same level and suture the two cut mucous edges. The cleansed stump is returned, and the bowel put at rest for a week or so.

The modification recommended consists in performing the Mikulicz operation over a proctoscope or a round billet of wood, introduced through the lumen of the prolapsed mass. The latter can readily be obtained by sawing off the end of a broomstick about fourteen inches in length and boiling it with the instruments.

The gut is held in place over this central supporting core by tying a piece of rubber tubing or kangaroo tendon around the neck of the prolapse just outside the anal margin. If the latter is used too much traction should not be made on the ligature or the tissues will be injured.

After the ligature is placed around the neck of the mass, an incision is made across the front of the prolapse about one-half inch below the ligature, using care on opening the rectovesical pouch that any coils of intestine that may be present are not injured. If any of the pelvic contents are encountered, loosen the ligature and replace them, readjust the ligature, and proceed as in the Mikulicz operation.

In adults the rectovesical pouch has an average distance of about three inches from the anus, but it may vary in different subjects from one to four and a half inches. The pouch is usually opened in this operation and care should be used that the contents are not injured.

The advantages offered by this technique are ease and rapidity of execution, the sutures being placed rapidly with accurate approximation of the bowel, while hæmorrhage is constantly under control. The whole procedure may be performed under local anæsthesia. More rapidity might be gained by using a clamp having semicircular blades, over which rubber tubing is drawn. The clamp is placed over the base of the prolapsed gut and the supporting proctoscope or billet of wood contained within, and is held in place by a ratchet on the handle.

AN UNCOMPLICATED AND CONVENIENT INTESTINAL ANASTOMOSIS CLAMP

By JOSEPH RILUS EASTMAN, M.D., F.A.C.S., Indianapolis, Indiana

THE intestinal anastomosis clamp shown in the accompanying illustrations has, it is believed, advantages of construction and application sufficient to justify a presentation of this instrument to anyone who is familiar with the technique of operations on the stomach and intestines.

In applying this clamp there need be no confusion as to which is the top or bottom of the instrument nor as to which is the right or left side.

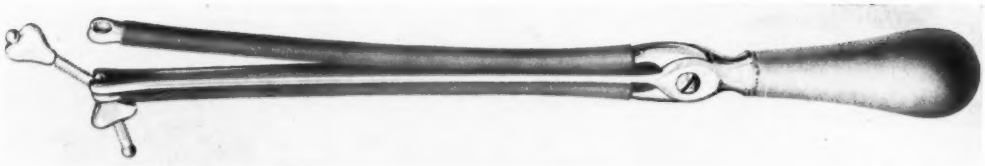


Fig. 1. An efficient and convenient anastomosis clamp of uncomplicated construction.

Pressure can be gauged accurately by turning the wing-nut which rests with a ball-seat in a concavity on the outer side of the end of each of the lateral bars. The wing-nut moves upon a short, thin, threaded lever which is attached by a hinge-joint to the end of the median bar. The lever swings radily into a slot at the distal end of the lateral bars or jaws of the clamp. It is quite easy to release pressure on either side without loosening the other side so that, for example, the intestine or stomach may be drawn up farther into the grasp of the clamp, if desired, on either side, without releasing the opposite side. This can be done with other intestinal anastomosis clamps; but as in the case of scissors-handled forceps, this step may require a little time and art.

After the introduction of the inner hæmostatic suture both sides may be released, so that the seroserous approximation secured by the outer suture may be accomplished without traction and consequent tearing out of the suture and without danger of the operative field slipping into the abdomen and out of convenient reach. The lever and wing-nut device at the distal end of the clamp has been used in other clamps and its value is well known to those who are familiar with the embarrassments incident to imperfect closure at the distal end of the anastomosis forceps. After completion of the anastomosis, the threaded levers are placed in alignment with the median bar before withdrawal of the instrument. The slanting margins of the heart-shaped wing-nuts and their small size prevent catching of the instrument as it is withdrawn. The median bar of the clamp is not so thick as it is in other clamps, thus minimizing the possibility of tension upon any of the sutures. The large proximal hinge-joint of the instrument has been made very heavy and strong intentionally with a view to securing durability and firmness.

In order to secure an elastic spring pressure along the full length of the clamp, the bars deviate gradually from the median bar in the distal half and are so tempered that the screwing down of the wing-nuts accomplishes firm pressure without crushing.

This instrument is light in weight, simple and convenient to use, holds the stomach or intestine firmly with nicely adjusted pressure, is easily and quickly applied and removed, and is inexpensive.

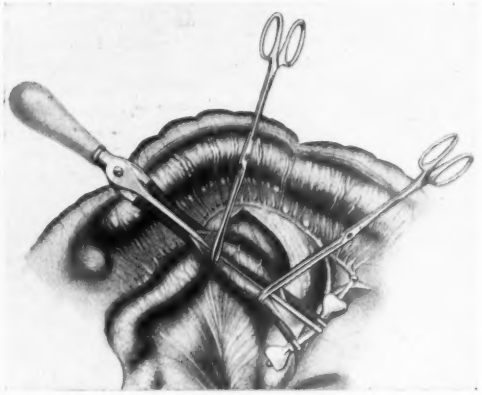


Fig. 2. Either side of clamp can readily be loosened for readjusting stomach or intestine by unscrewing the wing-nut.

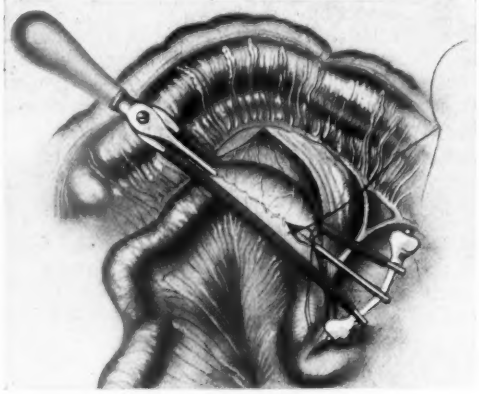


Fig. 3. Both sides of the clamp can be loosened to permit completion, the operative field still being held up in favorable position.

SEVEN DIAGRAMS ILLUSTRATING THE USE OF FAT TRANSPLANTATION IN KIDNEY AND BLADDER SURGERY

By G. KOLISCHER, M.D., Chicago

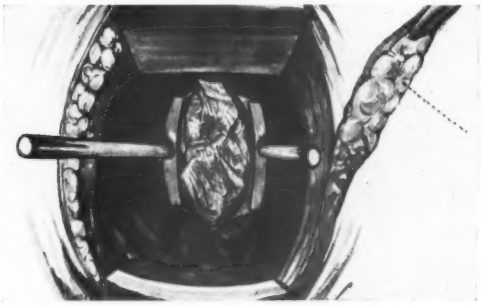


Fig. 1. Cavity resulting from enucleation of prostate temporarily packed with gauze. Exsection of free fat transplant out of abdominal wall.

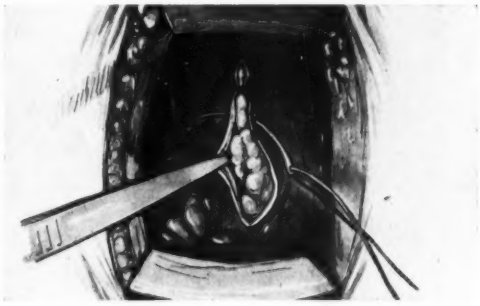


Fig. 2. Transplantation of fat into former site of prostate, two sutures anchoring transplant and narrowing upper angle of trigonal wound.

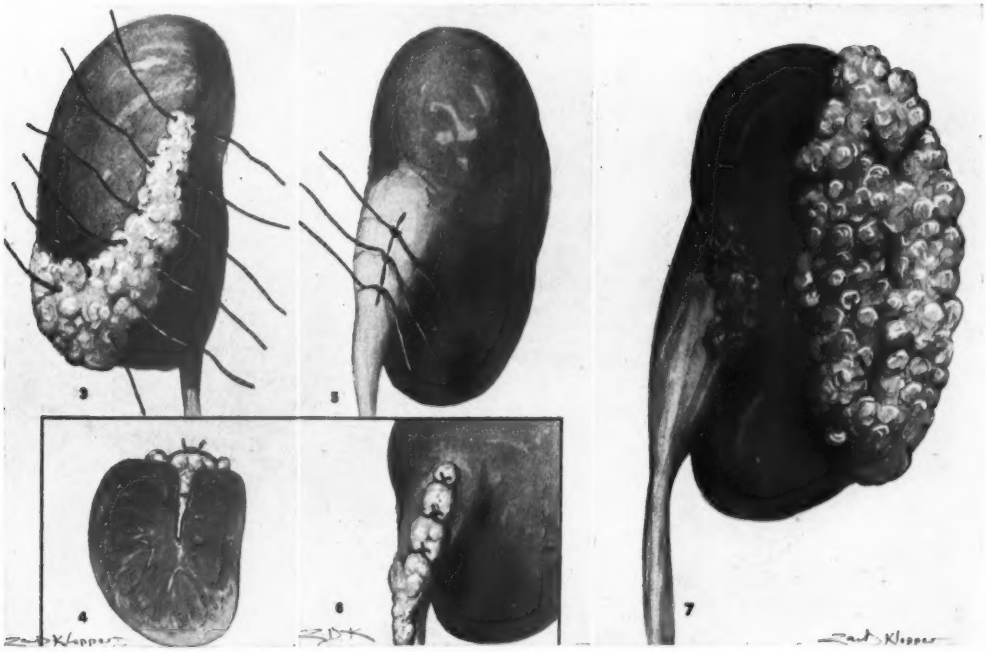


Fig. 3. Transplant of fat over traumatic rupture of kidney.

Fig. 4. Cross cut demonstrating insertion of sutures through fat and renal parenchyma.

Fig. 5. Renal pelvis closed after pelvotomy. The ends of the closing sutures left long.

Fig. 6. Attachment of fat for reinforcement of pelvic wall by tying the suture endings over the transplant.

Fig. 7. Flap of fat drawn over nephrotomy wound and anchored by mattress sutures, preventing suture from cutting through the renal parenchyma and utilizing the hæmostatic qualities of fat.

SIMPLE MECHANOTHERAPEUTIC APPARATUS FOR MILITARY HOSPITALS[1]

By JOSEPH MARSHALL FLINT, M.D., F.A.C.S., New Haven
Professor of Surgery, Yale University

IN a long-drawn-out struggle like the present war, the military problem in all probability will only reach a decision through the principle of wastage. Men, accordingly, are the most vital elements in the military campaign. Of the casualties that reach the hospitals of the interior, the largest possible percentage must be returned for service at the front. To a certain extent, therefore, the efficiency of the surgical service can be measured by the rapidity with which the convalescents are evacuated fit for active duty. Inasmuch as a large proportion of the wounds consists of fractures, which are often compounded or are of a nature that require prolonged fixation, a great many finally heal with joints stiffened either from injury, fixation, or disuse. In meeting this problem the French *Service de Santé* has established in many hospitals and regional centers elaborate departments of mechanotherapy. In the Grand Palais in Paris and the larger regional headquarters, institutes of physiotherapy equipped with expensive Zander apparatus are found to which patients requiring this treatment may be evacuated. There also have been developed in some of the smaller hospitals, departments of mechanotherapy, in which simple and cheap substitutes have been devised to replace the more elaborate and expensive Zander machines. This feature of the French military hospitals presents what, to my mind, is one of the most interesting phases of military surgery; namely, the invention of simple and inexpensive substitutes for things which it is either impossible to purchase at all or which cannot be bought because of the prohibitive cost. I have seen many remarkable instances of this

Fig. 1. View of the mechanotherapy room.

[1]From Hôpital 32bis Château de Passy, Fondation Fitzgerald.

Fig. 2. View of the mechanotherapy room.

type of adaptation in the French hospitals. In a sense, military surgery often becomes the surgery of adaptation, where one usually finds ample opportunity to exercise any amount of ingenuity in making temporary makeshifts.

Inasmuch as a military hospital only does its full duty to the Government, when it undertakes the rapid mobilization of joints that have been stiffened from some of the causes enumerated above, we installed in the Château de Passy a department of mechanotherapy. In a short time, it proved to be so useful that we not only had to double its capacity but also to duplicate much of the apparatus. The problem consists in making cheap and simple appliances by which any desired movements can be obtained in the joints through active or passive motion. The general character of the appliances which we constructed are shown in the accompanying photographs of the Mechanotherapy Rooms (Figs. 1 and 2). They consist for the most part of cheap carpenter work. Old packing cases provided the material, so that the cost was minimal, as labor was supplied by carpenters sent from the army reservists. As far as possible, we endeavored to have apparatus that gave normal movements of all the joints, actuated usually by swinging pendulums.

Fingers. For flexion and extension of the fingers, two types of apparatus were generally employed. One was copied from a machine which I used in the gymnasium as a boy. This consists of a series of wooden cylinders of gradually decreasing size arranged somewhat in the manner of a towel rack. The smaller cylinder is perforated and a cord passes through the hole and is tied. On the other end of the cord hangs a can of gravel which serves as a counterweight. The action of this apparatus is obvious. The patients beginning on the larger cylinders wind up the counterweight which is, in turn, unwound by manual movements. After beginning with the larger cylinders those of smaller size are progressively used. This machine provides an excellent exercise for the wrist as well as the fingers.

Another appliance for the fingers consists of a set of wooden cylinders each of which is covered

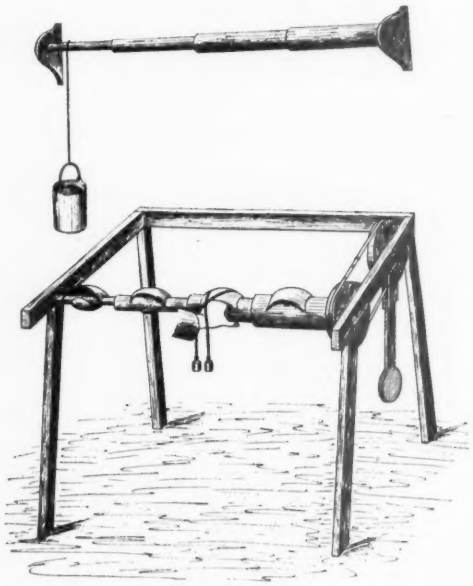


Fig. 3. Apparatus for mobilization of the fingers.

by a cuff into which the fingers are inserted. By an angle of counterweighted bands acting on these cuffs, the fingers are held against the cylinders. This apparatus is then set in motion by a heavily weighted pendulum, which causes the cylinders to move back and forth through an arc of about 60°. As flexion of the fingers is gradually regained, smaller cylinders are suc-

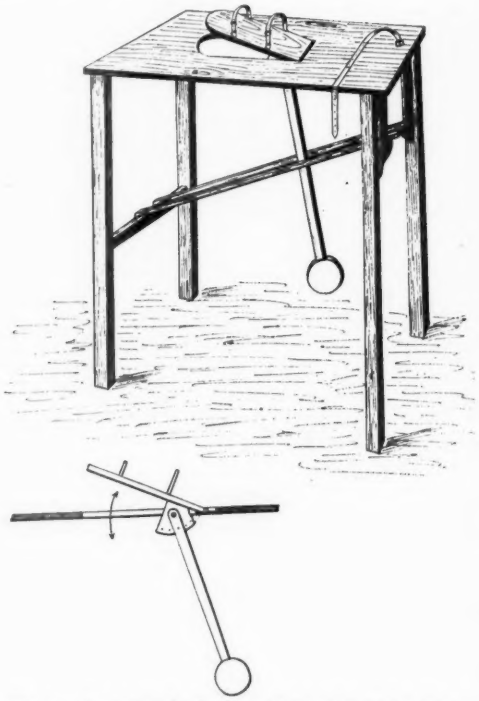
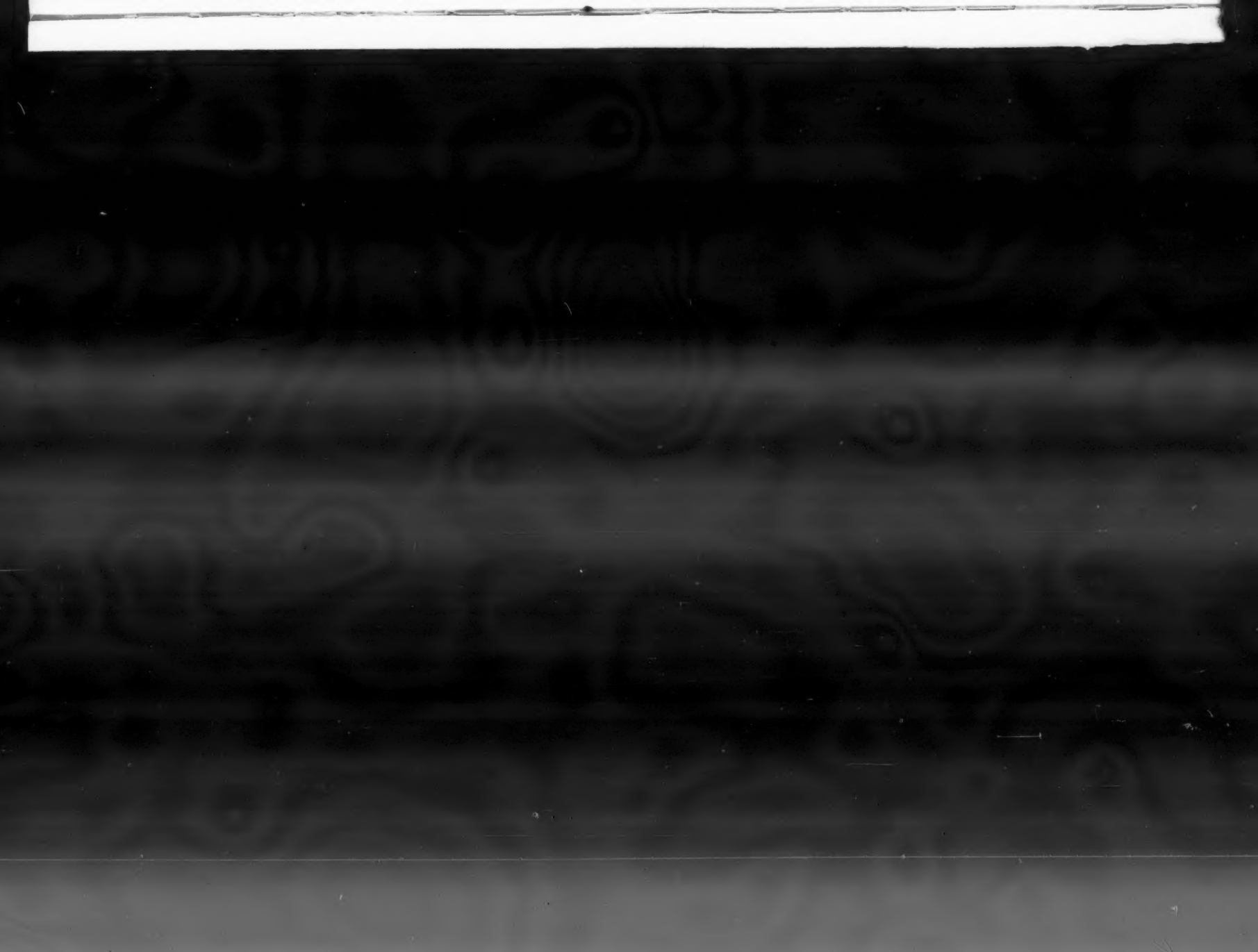


Fig. 5. Apparatus for flexion and extension of the elbow.

Fig. 4. Apparatus for flexion and extension, and pronation and supination of the wrist.



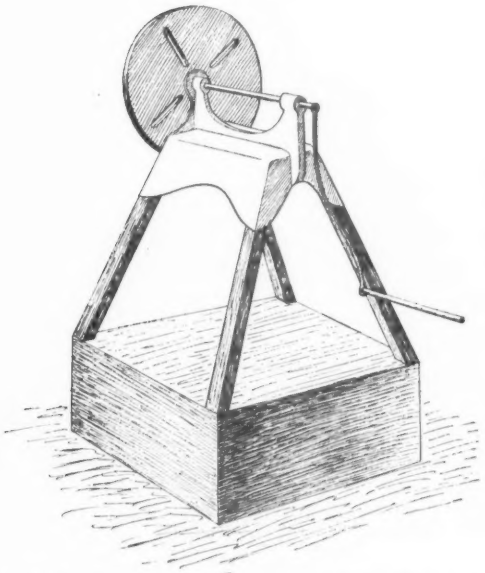


Fig. 6. Apparatus for circumduction of the shoulder.

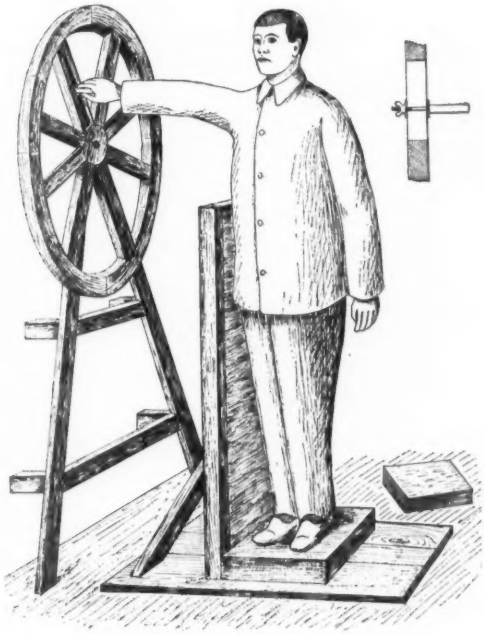


Fig. 7. Apparatus for circumduction of the shoulder, showing lateral support for the trunk.

cessfully used until both flexion and extension are complete (Fig. 3).

Wrist. Besides the counterweighted cylinders described above, where active motions of the wrist are obtained, we devised a special appliance for passive motions of this joint which consisted of a small trap-door in a shelf hinged on the proximal side. This is a trifle larger than the hand and is covered with a canvas cuff into which the hand is inserted. A heavily weighted pendulum swinging below maintains the motions of flexion and extension of the wrist through a gradually increasing arc. For pronation and supination, an appliance was employed which we copied from another hospital. This consists of an iron pendulum with a handle at right angles

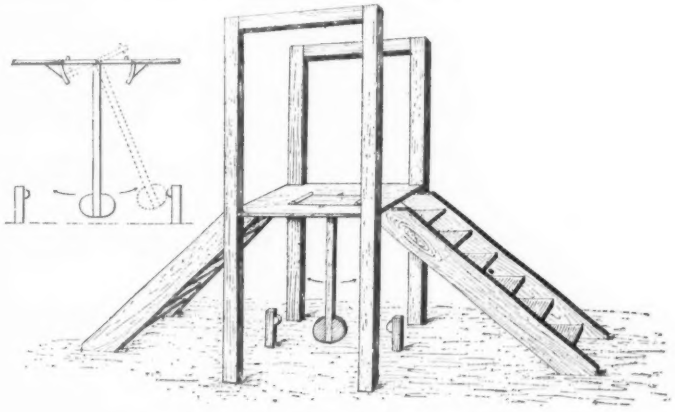


Fig. 8. Apparatus for flexion and extension of the ankle.

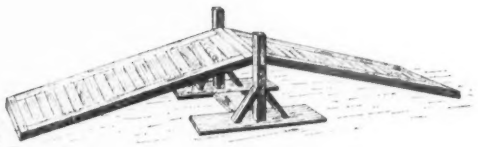


Fig. 9. Double inclined plane for flexion and extension of the ankle.

to the main shaft. With the forearm fixed upon the shelf, motions of the pendulum enforce pronation and supination as the handle is grasped by the patient. The details of these two appliances are shown in Fig. 4.

The elbow. The machine for flexion and extension of the elbow consists of a trap-door somewhat longer than that for the wrist, upon which the forearm can be strapped while the upper arm is fixed to the supporting table or shelf. This, like the wrist machine, is moved by a long pendulum. Inasmuch as the elbow-joint is not hinged directly at the tip of the olecranon, the apparatus has a slight sliding motion at the hinge which compensates for the eccentric movement of the elbow. The pendulum is attached to a trap-door by means of a perforated quadrant permitting the trap to be adjusted in any position, thus allowing movements of the joint to commence at any point within an angle of 90°. For the comfort of the patients, pads are inserted under both the forearm and the upper arm before the straps are tightened. The details of this apparatus are shown in Fig. 5.

The shoulder. For circumduction of the shoulder-joint, an apparatus was constructed out of an old beet chopper which served our purpose excellently. This heavy disk of iron when in motion has a sufficient momentum to circumduct the shoulder by means of a handle with a fairly large radius. Patients, however, with any marked limitation of motion of the shoulder-joint showed a tendency to operate this machine by motions of the body. This led to the construction of a similar apparatus in which the angle of circumduction could be adjusted by a movable handle upon a wheel. Partial fixation of the trunk was obtained by a lateral body support. For combined movements of the upper extremities as well as the back, a series of home-made pulley weights were installed which are shown in Figure 1. The details of the shoulder appliances are indicated in Figs. 6 and 7.

Ankle. Movements of the ankle-joint are obtained by an appliance illustrated in Fig. 8, which consists of a small trap-door hinged in the middle and swung by a heavy pendulum below. Cleats are placed at the end to prevent the feet from slipping. Guards are also provided beneath the platform to avoid the possibility of the toes being caught between the trap-door and the surrounding platform. The patient supports himself by grasping the hand rails. The stairway used in ascending and descending the platform is likewise excellent exercise for the ankle. Another appliance for the ankle-joint which we found serviceable particularly in commencing the active movements is illustrated in Fig. 9. It consists of an adjustable inclined plane, the height of which can be regulated at will. In ascending and descending this plane, the first movements of the joint are most readily attained. Exercise of the ankle as well as the knees and hips can likewise be given by an old bicycle mounted upon a wooden stand. When the rear tire is replaced by a lead pipe, there is considerable inertia to overcome in starting and likewise considerable momentum in stopping it, both of which tend to encourage the movements of the ankle as the feet are strapped in the pedals. As progress is made in the mobilization of the joint, the work which the patient does can be increased by the application of a simple brake to the rear wheel. The arrangement of the bicycle as a mechano-therapeutic apparatus is shown in Fig. 10.

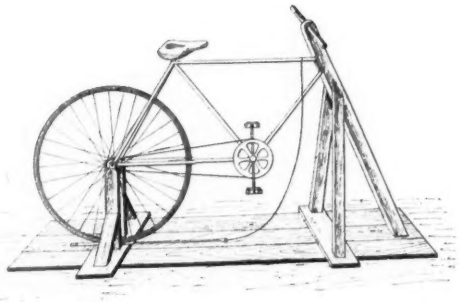


Fig. 10. Apparatus for the ankle, knee, and hip.

Knee. The apparatus for the mobilization of the knee is one which we copied from a hospital in Orleans and which proved extremely useful in overcoming stiffness of the knee-joint after fixation from either injury or disuse. It consists of a table with four small openings making it possible to strap the thigh just above the knee to the table, upon which the patient can lie prone. The knee is protected by a simple pad and the patient is permitted to rest his head and chest upon a pillow. The motive power is provided

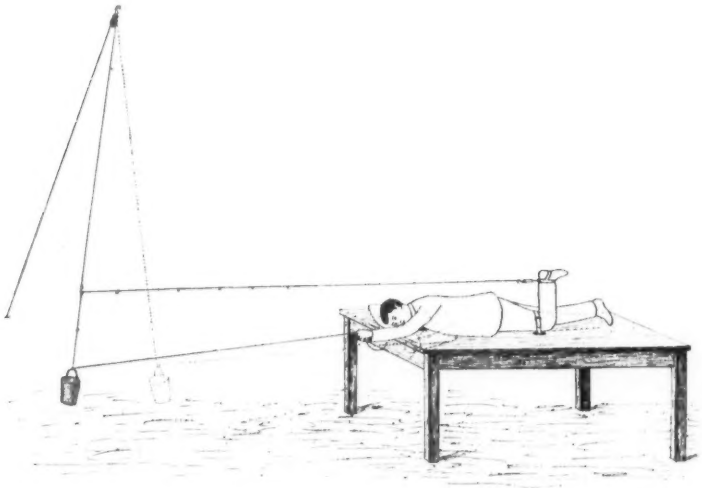


Fig. 11. Apparatus for flexion and extension of the knee.

by a fairly heavy pendulum consisting of a pail filled with stones or iron which is lifted from the floor by a cord passing through a pulley in the ceiling. This cord has a hook upon the end which is inserted into one of a series of rings attached to another cord which extends from the handle of the pail to a simple harness fixed upon the ankle of the patient. A second cord is attached to the pendulum by which the patient swings it. An ordinary helical spring, such as found in a fish scale is inserted in the harness to ease any jerking movements of the pendulum. This is likewise facilitated by the elasticity of the cords. By changing the insertion of the hook in the rings, the arc in which the pendulum swings is modified so that the pull upon the leg can be changed to any desired degree. In commencing mobilization of a stiff joint with this apparatus, the hook is inserted in the ring nearest the ankle, which gives a relatively small arc and consequently a definitely limited motion. As the mobilization of the joint progresses, the hook is attached nearer and nearer the counterweight until movements of more than 90° at the knee are easily obtained. (Fig. 11).

Re-education in walking. It not infrequently occurs that patients having fractures or injuries of the lower extremities recover with a bad position of the foot which may be either inverted or everted, most frequently the latter. When there are no definite mechanical factors responsible for this malposition, it only requires effort on the part of the patient to overcome the defect in gait. For this purpose what might be termed a double prone ladder with steps of different height is used, the smaller and larger steps being opposite each other. This inequality in height forces the patient to pay attention to the position of his feet, especially as the boxes into which he steps are just wide enough to accommodate them comfortably. This apparatus forces the patient to pay strict attention to the position of the feet during each step and consequently he rapidly overcomes the careless habits of gait into which one who has had fractures or painful injuries of the lower extremity is apt to fall. The details of this apparatus, which we copied from another hospital, are shown in Fig. 12.

So far as I know, no description of simple mechanotherapeutic apparatus of this type exists in the American literature. I have, accordingly, thought it worth while to publish illustrations and descriptions of our appliances. More study than we were able to give this problem would undoubtedly result in the invention of machines much better than those we employed. It is also not impossible that apparatus of this type might be found useful in a civil hospital with an active fracture service, which could not afford the Zander appliances.

Fig. 12. Apparatus for re-education in walking.

TRANSACTIONS OF SOCIETIES

JOINT MEETING OF THE CHICAGO MEDICAL AND CHICAGO GYNECOLOGICAL SOCIETIES, HELD FEBRUARY 16, 1916

DR. CHANNING W. BARRETT, PRESIDENT OF THE CHICAGO GYNECOLOGICAL SOCIETY, IN THE CHAIR

THE BEGINNING OF THE BIRTH-CONTROL MOVEMENT

Prof. JAMES A. FIELD, read a paper on "The Beginning of the Birth-Control Movement" (see p. 185).

SOME PRACTICAL ASPECTS OF BIRTH-CONTROL

DR. RACHELLE S. YARROS contributed a paper entitled "Some Practical Aspects of Birth-Control" (see p. 188).

SIMPLE METHODS OF STERILIZING WOMEN BY OFFICE TREATMENT, PRODUCING CHEMICAL OR CAUTERY STRICTURES OF UTERINE OPENINGS OF FALLOPIAN TUBES

DR. ROBERT L. DICKINSON, of Brooklyn, New York, followed with a paper entitled "Simple Methods of Sterilizing Women by Office Treatment, Producing Chemical or Cautery Strictures of Uterine Openings of Fallopian Tubes" (see p. 203).

DISCUSSION

DR. CHARLES S. BACON: Everything that has been said by Dr. Dickinson in his paper, not only on the subject of sterilization but the incidental subject he has alluded to, has been very suggestive. I shall not attempt any remarks upon the method, only to say that any method that can be used for artificial sterilization for tuberculous women and women with heart disease, and others that need sterilization, is to be welcomed.

I might perhaps say a word on the subject presented by Professor Field and on the paper of Dr. Yarros, although I have not sufficiently thought of the subject to come to any conclusion as to the solution of this problem. The older methods of limiting population were those of fœticide and infanticide. They were both practiced among certain tribes and certain nations at certain times, and were more or less common and allowed by the moral sentiment existing at that time; but gradually the dangers of infanticide were recognized. The dangers of fœticide or abortion have become in recent time very well known, so well known in fact that an international society has been founded for prevention of criminal abortion. The great danger in criminal abortion is infection, which leads to the sacrifice of a great many women.

The objections to abortion, of course, are not confined to the danger of life of the mother. A serious element of danger in undermining the moral and religious sentiment has to be considered. When the nature of fertilization became known, it was evident that childbearing might be prevented in other ways than by fœticide and infanticide; and just as we know now how to prevent contagious diseases the causes of which are known, so, as the knowledge of fertilization comes to be generally known, it follows that with the same knowledge we will be able in most instances to determine how pregnancy may be prevented.

It would seem, looking at the matter frankly, that there was certainly very much less danger from this method of controlling birth than from the older methods. That there is not any danger nobody would say, for the danger to life certainly does exist.

As Professor Field has pointed out, it does seem as if this movement has come to stay; that it is impossible to prevent it by any legal or other means. We must study the facts. Is the danger to the woman or to the pair that practice this method, or is the chief danger to society? If there is a danger, and I do not deny that there is to society, a certain danger of race suicide to the nation, I think that is the chief danger felt by those in authority. That danger can be averted to a great extent by economic measures. The giving by the state of premiums, of pensions for childbearing, would amount to the same thing as taxing bachelors. Various sociologic and economic measures will probably overcome the social dangers that would result from the extension of this practice.

DR. ANNA E. BLOUNT: It is extremely gratifying to me to hear this subject discussed by grave and dignified people.

Professor Field has called our attention to the fact that the propaganda of birth-control has been mainly in the hands of the ultra-radicals. It may be said, also, that its discussion in many cases has been associated with more or less obscenity, more or less plain coarseness, so much so that when the Eugenic Society proposed a meeting on birth-control, one of the members came to me and said

it would be much better if we would call it something else, because of the coarseness which had been indulged in in a discussion on this question at some of the meetings that had been held in the city. It is a question that should be taken up on the highest moral grounds.

The first question to decide is whether it is a proper propaganda from the point of view not only of the individual family but from the standpoint of the nation; whether we are going to deteriorate our population. As Conklin says: "The highest human responsibility we have is for the propagation and improvement of the human race."

Shall we diminish the propagation of the human race, or shall we deteriorate its quality by means of this propaganda? I would call attention to the fact that I think our actual practice has gone far ahead of our discussion; that we as physicians have been willing to put our heads in the sand like ostriches whenever the subject was mentioned, and no radical woman's club could be persuaded to touch the subject, or could not be a few years ago.

It has been shown by statistics that a Harvard graduate has on an average three-quarters of a son, and a Vassar graduate one-half of a daughter. It has been shown further that the families of scientific men are only about one-half as compared with the families of their fathers and their grandfathers. The studies of Sidney Webb and various others, as well as all the evidence I have seen, have shown the intellectual classes are diminishing in numbers; that the birth-rate among the intellectual classes is diminishing very rapidly, while the birth-rate among the morons and feeble-minded is not diminishing at all. The average birth-rate of the married feeble-minded in London is given at about 6 and of Edinburgh at about 7; while Professor Hickson says that the average birth-rate in our own country for the same class of people is about 8; whereas the Harvard graduate in proportion has three-quarters of a son. As a matter of fact, the well to do, if they want to control birth-rate, go to a physician's office, receive advice, and pay a fee; but the poorer classes, and the least desirable classes, those that have been selected through many generations, cannot pay for this advice, and the European peasant, the intellectual peasant, cannot exist. He must go to Paris or some other center of population, or must die. His family must become extinct, consequently that class of European peasants, who have been carefully and thoroughly selected and bred, are increasing with rapidity, whereas the intellectual class is not increasing at all.

I am well aware of the truth of what Professor Bacon has said with reference to the killing effect of the moral end of women that is coming from the almost unlimited number of early abortions which are being performed today. I wish we could substitute more knowledge on this subject; but I think when the propaganda of birth-control has become universal we will require another propaganda before we will achieve any real benefit to the human race, and that is the propaganda for voluntary motherhood. It needs to become the style, the fashion, for women to have fine children. It is a matter which is entirely capable of developing into a reform movement, and yet it is the one subject upon which until today we have chosen to be silent. We have chosen to dismiss the subject as soon as it was introduced.

DR. RUDOLPH W. HOLMES: There is only one thought I wish to bring out in line with what Dr. Blount has said, and that is: intelligent people will know how to employ expedients for the prevention of conception, whereas the moron will not learn; he never will have enough mentality to practice restraint, and therefore, he will propagate his species unless the state assumes control, and does vasectomy on all male morons, as well as sterilizing the women, as pointed out by Dr. Dickinson. That is the only way to improve the race.

DR. FRANCES DICKINSON: One of the reasons for so few children among Harvard graduates and the graduates of other universities is a greater prevalence of gonorrhœa among them than among working men. The well-to-do men are more apt to be the subjects of gonorrhœa than working men. The latter are too busy all day long to give attention to such matters. This is only one of many angles in considering this great subject, but nevertheless should be borne in mind.

DR. ALICE HAMILTON: My knowledge of the birth-control movement is purely theoretical, as I have never been a practicing physician. Last summer in Holland, England, and Germany, I was thrown in with some of the prominent Neo-Malthusians and heard from them of the progress of this propaganda in Europe. There are leagues for the spread of the teachings of Neo-Malthusianism, that is of deliberate restriction of the birth-rate, in Great Britain, Holland, Belgium and Flemish Belgium, Germany, France, Bohemia-Austria, Switzerland, Spain, Cuba, Brazil, Sweden, Italy, Portugal, Africa and the United States. These have united to form a Fédération Universelle de la Régénération Humaine, which has held three international meetings and was to have held a fourth the year the war broke out.

The objects of the federation are stated as follows: (1) To spread among the people, by all practicable means, a knowledge of the law of population, of its consequences, and of its bearing upon human conduct and morals. (2) To urge upon the medical profession in general, and upon hospitals and public medical authorities in particular, the duty of giving instruction in hygienic contraceptive measures to all married people who desire to limit their families, or who are in any way unfit for parenthood, and to take any other steps which may be considered desirable for the provision of such instruction.

The Neo-Malthusians emphasize always a distinction which seems to be far from clear in this country, one indeed which seems not always to have

been made this evening, the distinction being between the production of abortion and the prevention of conception. On all their pamphlets and other publications are these words prominently displayed: "The Council of the Neo-Malthusian League calls attention to the fact that it has as its sole object the prevention of conception, and not the causing of abortion." They maintain that this confusion is fostered by laws such as those in our country in which the two are always classed together, giving the idea that both are equally criminal or equally innocent, and they believe that the enormous number of deliberately produced abortions in the United States is largely due to the suppression of discussion concerning the prevention of conception.

There are laws in all these countries which may be and occasionally are invoked to put a stop to the advocacy of restriction of families, but in none is the prosecution nearly as active as in the United States, and ours is the only country to which the pamphlets of the federation are not freely sent by mail. In Holland, where the movement has been actively pushed for several decades, a pamphlet may be secured by anyone who asks for it, in which directions as to the prevention of conception are given in simple and understandable language. In Great Britain a similar booklet may be sent to anyone who signs a blank stating that he or she is married or about to be married. During the past two years the persecution of Neo-Malthusians has fallen off very much in all European countries, and the international defense committee was called on only once for pecuniary aid.

The success of the movement is said by its followers to be shown not so much by the number of open adherents as by the falling birth-rate, observable in every highly civilized land in the last half century. With this falling birth-rate has gone a parallel drop in the infant death-rate, so that the rate of increase has kept up even when the cruel and wasteful method of large families and many deaths was replaced by the saner and more humane method of small families and few deaths. France, in 1781, had no higher a rate of increase with a birth-rate of 39 than in 1901 with one of only 21. The fall of 17.8 in births was compensated for by the fall of 17.5 in deaths.

DR. ROBERT L. DICKINSON, Brooklyn, New York (closing): I am glad to have come such a long distance to hear such a discussion. I feel a little jealous that you should have started, in a professional and dignified way, a frank discussion of a subject that we in the East have not undertaken.

The Society for Moral and Sanitary Prophylaxis in New York, of which Prince Morrow was the dignified and able head, has done much. We have had many meetings, and there was no meeting held at the Academy of Medicine of New York which was more largely attended than a meeting of this kind. We are not as much given to medical meetings as we ought to be. But that this is a live subject is shown by the audience here tonight.

I think no stranger note has been struck here this evening, and none that ought to cause more reverberation, than the claim that we as a profession should take hold of this matter and not let it go to the radicals, and not let it receive harm by being pushed in any undignified or improper manner.

CORRESPONDENCE

FIRST EXAMINATION BY NATIONAL BOARD OF MEDICAL EXAMINERS

The first examination by the National Board of Medical Examiners will be held in the Army Medical Museum, Washington, D. C., during the week beginning Monday, October 16, 1916. No charge will be made for the examination itself, but a registration fee of $5.00 will be required. The aim of this Board is to establish a standard of examination and certification of graduates in medicine through which, by the co-operation of the individual boards of medical examiners, the recipients of the certificates of the National Board of Medical Examiners may be recognized for licensure to practice medicine.

Credentials of candidates for examination must be presented to the Board sufficiently early for investigation. The requirements for admission to the examination include: completion of a four-year high school course, two years of acceptable college work, graduation from a class "A" medical school and one year as interne in an acceptable hospital or laboratory.

The written examination will be held in the Army Medical Museum, the oral and laboratory examinations will be held in the Army and Navy Medical Schools and in the Hygienic Laboratory of the Public Health Services, and clinical examinations in the Government Hospitals.

For particulars address the Secretary, J. S. Rodman, M.D., 2106 Walnut St., Philadelphia.